UBM Electronics

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VOICE OF THE ENGINEER

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RAISE A GLASS: ***EDN*'s 2010 INNOVATOR AND INNOVATIONS OF THE YEAR**

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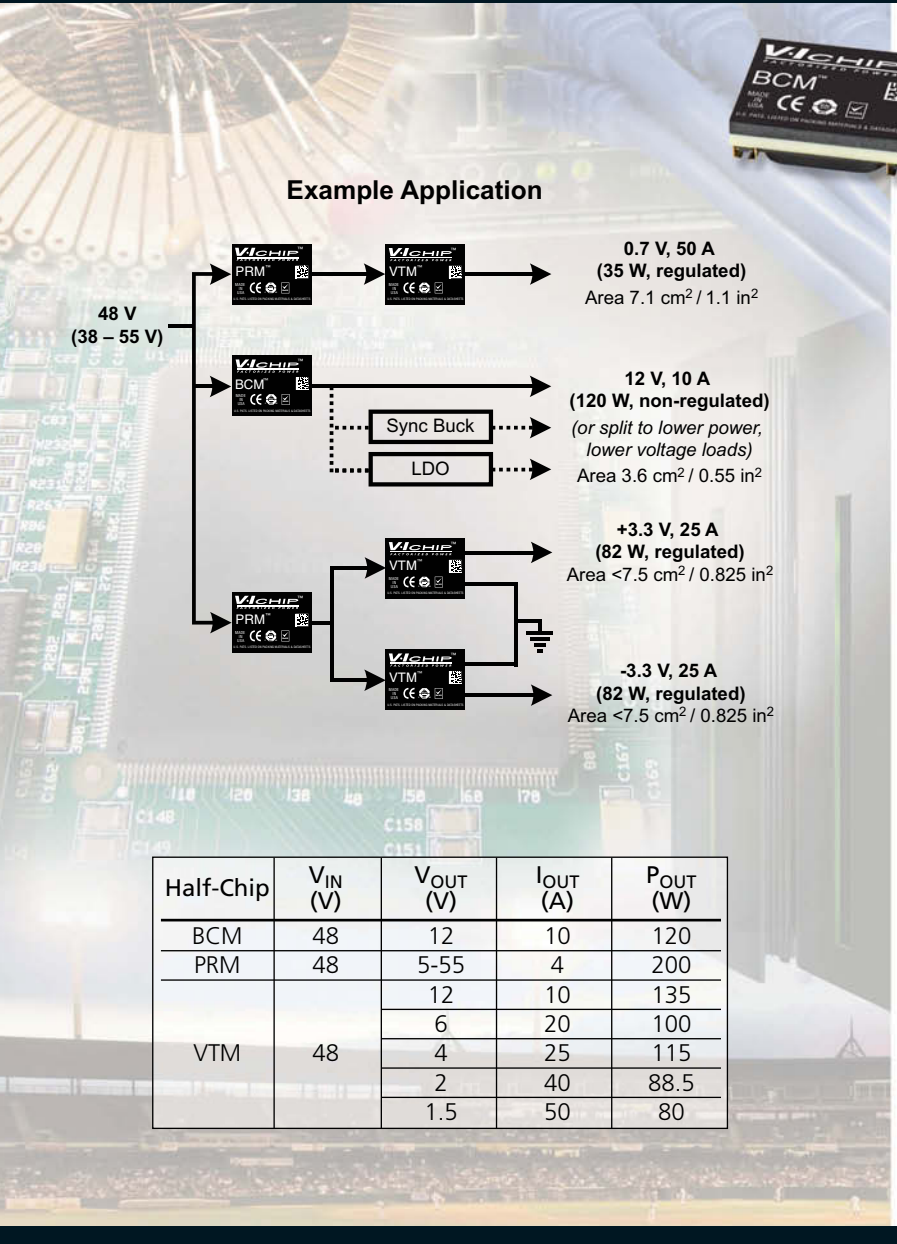
Twice the Power
Half the Size

New family of high-density power components enables fast, adaptable designs



Half-Chip	V_{IN} (V)	V_{OUT} (V)	I_{OUT} (A)	P_{OUT} (W)
BCM	48	12	10	120
PRM	48	5-55	4	200
VTM	48	12	10	135
		6	20	100
		4	25	115
		2	40	88.5
		1.5	50	80

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EDN 5.12.11 contents

RF predistortion straightens out your signals

by Paul Rako, Technical Editor

Implementing and comparing video over USB

by Sonia Gandhi and Ashwini Govindaraman, Cypress Semiconductor

pulse

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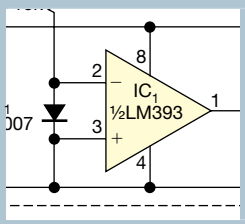
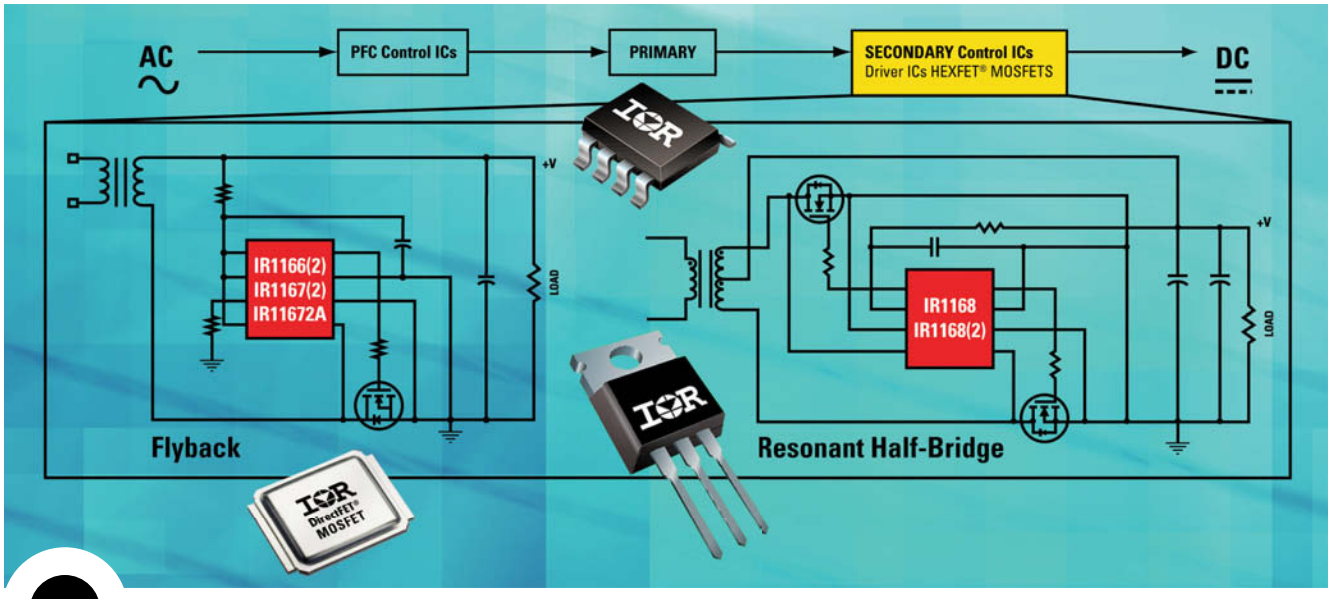
Raise a glass: *EDN*'s 2010 Innovator and Innovations of the Year

DESIGNIDEAS





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IR1166SPBF	SO-8	20	200	500	+1/-4	10.7	Program. 250-3000	Yes	1	No
IR1167ASPBF					+2/-7	10.7		Yes		No
IR1167BSPBF						14.5		Yes		No
IR1168SPBF					+1/-4	10.7	750	No	2	No
IR11662SPBF					+1/-4	10.7	Program. 250-3000	Yes	1	Yes
IR11672ASPBF					+2/-7	10.7		Yes		Yes
IR11682SPBF				400	+1/-4	10.7	850	No	2	Yes

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IRF6646	DirectFET MN	80	9.5	36.0	12.0
IRF6644	DirectFET MN	100	13.0	35.0	11.5
IRF6643	DirectFET MZ	150	34.5	39.0	11.0
IRF6641	DirectFET MZ	200	59.9	34.0	9.5

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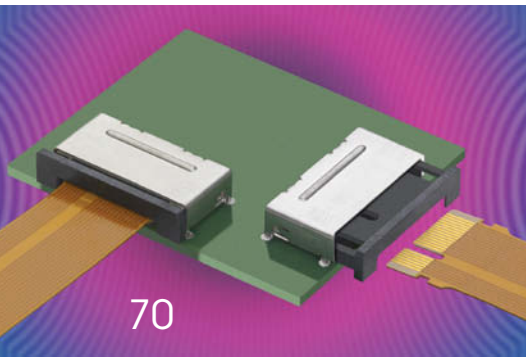

DEPARTMENTS & COLUMNS

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Check out this Web-exclusive article:

Japan disaster calls capacity, supply into question
Weeks after the earthquake, tsunami, and nuclear crisis in Japan, the industry is still keeping a close global watch on semiconductor capacity and supply.
➔www.edn.com/110512toca

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FROM *EDN*'s BLOGS

Two approaches to modeling LEDs: Derive your own, and go online
From PowerSource, by Margery Conner
Device models can be useful tools, and it would be nice to have complete ones readily available for simulating LED circuits.
➔www.edn.com/110512tocb

Sony's PlayStation network hacked wide open
From Brian's Brain, by Brian Dipert
I'm utterly speechless, aside from the following thought, prompted by both this situation and Amazon's recent multiday EC2 (Elastic Compute Cloud) downtime: How's that whole cloud-computing thing working out for ya, folks?
➔www.edn.com/110512tocc

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BY RON WILSON, EDITORIAL DIRECTOR

FPGAs try to get embedded

If you were to judge by the marketing plans of FPGA vendors, you might call 2011 the year of the embedded system. FPGAs are no longer content to dominate in the specialized halls of network-equipment designers or to serve as a convenient medium for glue logic and bus bridges in other embedded-system applications. FPGA vendors now have their hearts set on the hearts of embedded designs: the computers at the centers of the systems.

In this vision, capacious but inexpensive FPGAs—armed with soft CPU cores, memory compilers, libraries of peripheral controllers, and pushbutton system-building tools—storm across the embedded-system landscape, displacing older, less flexible technologies. FPGA vendors cite as benefits reduced inventories, hardware that exactly matches system requirements, and freedom from fear over the obsolescence of single-sourced critical parts. Mostly, however, they repeat the traditional FPGA slogan: flexibility.

Beyond this scenario lies an even grander vision: embedded designs as purely software projects. Just write the code, say these advocates; don't worry about the hardware. Treat peripherals as just code on the other end of function calls. When your code is working, feed it, your performance and power requirements, and a description of the surrounding board into our magic tool chain. Then, just press the button. Our tool will instantiate CPU cores and memories, infer peripheral controllers, and organize your code. Our stuff will even identify code segments that require greater performance, and compile hardware accelerators from them. Naturally, the whole hardware subsystem that results will fit into our FPGA.

Unfortunately, even as the vision of FPGA conquest grows grander, actual design practice appears to be moving in the opposite direction. In *EDN*'s 2010 "Mind of the Engineer" study, you told us that fewer designs—not more—are using FPGAs.

Many of the reasons are familiar. FPGAs are expensive, you said, at least on a unit-cost basis. They consume a lot of power. The design methodology is unfamiliar. Most designers, after all, don't come from an ASIC background. They don't start their implementation flow in RTL (register-transfer-level) logic, do extensive simulations, or have a stage in their flow that corresponds to mapping a netlist onto an FPGA switch map.

The reason you cited most frequently for not using FPGAs, however, was something different altogether: You don't need the flexibility. This objection goes to the heart of the FPGA value proposition.

One interpretation of this result might be that designers of embedded hardware are conservatives who never change their design until they have painted themselves into a corner. A quick survey of modern designs refutes this premise, however. There is a lot of variety out there.

A more nuanced suggestion is that embedded-system teams need flexibility, but not the clean-sheet-of-paper flexibility FPGAs offer. FPGAs, for example, are great ways to implement custom processors, allowing you to co-optimize an algorithm, a datapath, and a memory structure. But how many embedded-design teams include algorithm experts and datapath designers? Similarly, FPGAs have become great places to easily synthesize multiple CPU cores into multicore clusters, but how many embedded teams really want to know what is going on inside a symmetric-multiprocessing cluster?

Perhaps the hardware flexibility embedded-system designers really need is already available in the microcontroller market. ARM's silicon partners, Microchip with its MIPS cores, and other vendors with their proprietary 32-bit cores have made the once-simple microcontroller into a population of 32-bit SOCs (systems on chips) with multiple CPUs, substantial on-chip memory resources, high-speed DRAM interfaces, complex—often programmable—accelerators and peripheral controllers, high-speed serial I/Os, and network interfaces. These vendors have thus erased the distinction between advanced microcontrollers and ASSPs (application-specific standard products) and removed the need for most design teams to retain advanced digital- or system-design skills.

The reason you cited most frequently for not using FPGAs was something different: You don't need the flexibility.

FPGA vendors still have a strong case to make for a share of the embedded-system market outside their networking citadel. That case must rest upon total cost of ownership, not flexibility, processing power, or ease of use. EDN

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pulse

INNOVATIONS & INNOVATORS

Data-plane-processor IP quadruples data bandwidth, doubles instruction size to 128 bits

Tensilica's new Xtensa LX4 DPU (data-plane processor) for SOCs (systems on chips) has four times more local data-memory bandwidth than the previous-generation LX3 DPU. The LX4 supports as many as two 512-bit load/store operations per cycle and doubles VLIW (very-long-instruction-word) instruction width from 64 bits to 128 bits for increased parallel processing. By applying the cache-memory-prefetch feature in the LX4, you can increase performance in systems with long off-chip latency by fetching data from system memory before its use. Tensilica has applied the capabilities of the LX4 DPU in the recently introduced ConnX BBE (baseboard engine) 64 DSP for LTE (long-term-evolution) Advanced communications (see "High-performance DSP-IP cores are ready for LTE-Advanced," *EDN*, March 3, 2011, pg 12, http://bit.ly/eMzbUS).

With the Xtensa LX4 DPU, you can create wide SIMD (single-instruction/multiple-data) DSPs that send more data per clock cycle to MAC (multiply/accumulate) units. You can apply the Xtensa LX4 in applications such as wired and wireless baseband processing, video preprocessing and postprocessing, image-signal processing, and network-packet-processing functions. With Tensilica's customizable local port and queue interfaces, you can also make connections between Xtensa DPUs and other system blocks in the same manner as with traditional RTL (register-transfer-level)-block interconnections.

The LX4 DPU increases the size of Tensilica's FLIX (flexible-length-instruction extensions) instructions from 64 to 128 bits, so that you can execute twice as many independent operations per clock cycle. You can intermix FLIX instructions with Tensilica's shorter Xtensa base instructions to achieve smaller code size than that of other VLIW DSPs. Tensilica's Xtensa C/C++ compiler automatically extracts parallelism from source code and bundles multiple operations into single FLIX instructions.

The DPU also comes with the company's Vectorization Assistant tool, which offers suggestions to developers on how to improve compiler vectorization of their C code when running on SIMD DSPs. The tool provides explanations of which operations are preventing further vectorization so that you can improve your C code to take advantage of the DPU's parallel execution units. The base Xtensa LX4 DPU can achieve speeds greater than 1 GHz. Tensilica manufactures the LX4 in a 45-nm 45GS process technology, and the IP (intellectual property) occupies an area of 0.044 mm^2. **—by Mike Demler**

▷**Tensilica**, www.tensilica.com.

The Xtensa LX4 data-plane processor for SOCs has four times more local data-memory bandwidth than the previous-generation LX3.

TALKBACK

"Does the emperor have no clothes? Is everyone so entertained by this discussion that no one wants to state the obvious?"

—*EDN* reader Bill Teasley, in *EDN*'s Talkback section, at http://bit.ly/ehr3fg. Add your comments.

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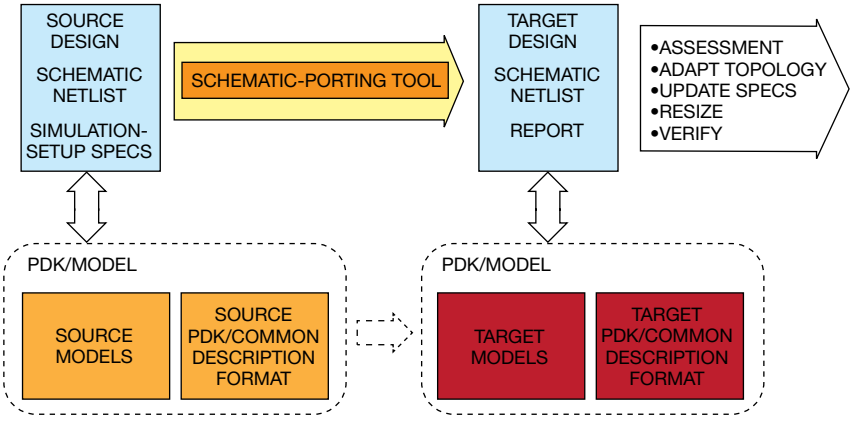
Tool enables process migration for circuit schematics

MunEDA has released the new Wicked SPT (schematic-porting tool), which enables designers to automatically transport circuit schematics and IP (intellectual property) among process technologies and PDKs (process-design kits). The tool supports migration in TSMC (Taiwan Semiconductor Manufacturing Corp, www.tsmc.com) process technologies from TSMC's 65- and 40-nm processes, but you can also configure the tool for other process-migration paths.

Wicked SPT automatically replaces cells in the source PDK with corresponding cells for the target PDK. The tool provides flexible property mapping and enables designers to automatically shrink devices such as MOS transistors, resistors, and capacitors. Wicked SPT is initially available in TSMC processes, but MunEDA plans to set up further process technologies on request. Cadence's Virtuoso custom analog flow also integrates Wicked SPT. MunEDA has begun shipping Wicked SPT. Prices start at $25,000 for a single one-year time-based license.

—by Mike Demler

▷**MunEDA**, www.muneda.com.



The Wicked SPT tool automates process migration, replacing legacy cells with the corresponding cells in the new process, mapping and shrinking the properties of MOS, inductance, capacitance, and other components as it walks hierarchically through the schematics.

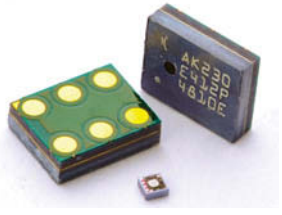
Single-chip MEMS-based digital microphone shrinks to fit laptops, notebooks

The insides of laptop and table computers are inherently noisy environments. Keyboards and antennas create interference for electronically sensitive devices, such as the system microphone. Fortunately for designers, MEMS (microelectromechanical-system)-based digital microphones are inherently noise-resistant. Akustica has released its fourth-generation AKU230 chip, which the company claims is the only MEMS-based digital microphone to include the microphone membrane, amplifier, and sigma-delta converter on one die, which measures just 7 mm^2. Bosch (www.bosch.com) in 2009 purchased Akustica; the part is the first in the Bosch supply chain.

The AKU230 package fits the industry-standard footprint of 3.76×4.72 mm and measures 1.25 mm tall in its LGA package. It features –26-dB±2-dB sensitivity, 56-dB typical SNR (signal-to-noise ratio), and –57-dB PSSR (power-supply-rejection ratio). Its closely matched sensitivity control and stereo-microphone data multiplexing are important for dual-microphone arrays that allow directionality and noise suppression. The price is $1.30 (10,000).

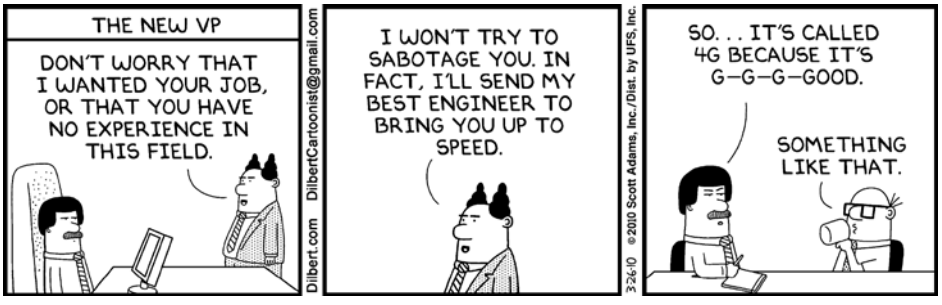
—by Margery Conner

▷**Akustica**, www.akustica.com.



The MEMS-based AKU230 digital-microphone chip includes the microphone membrane, amplifier, and sigma-delta converter on one die measuring just 7 mm^2.

DILBERT By Scott Adams



Need a 470 to 510MHz FSK Transceiver for your Wireless Meter Network? Micrel has you Covered.

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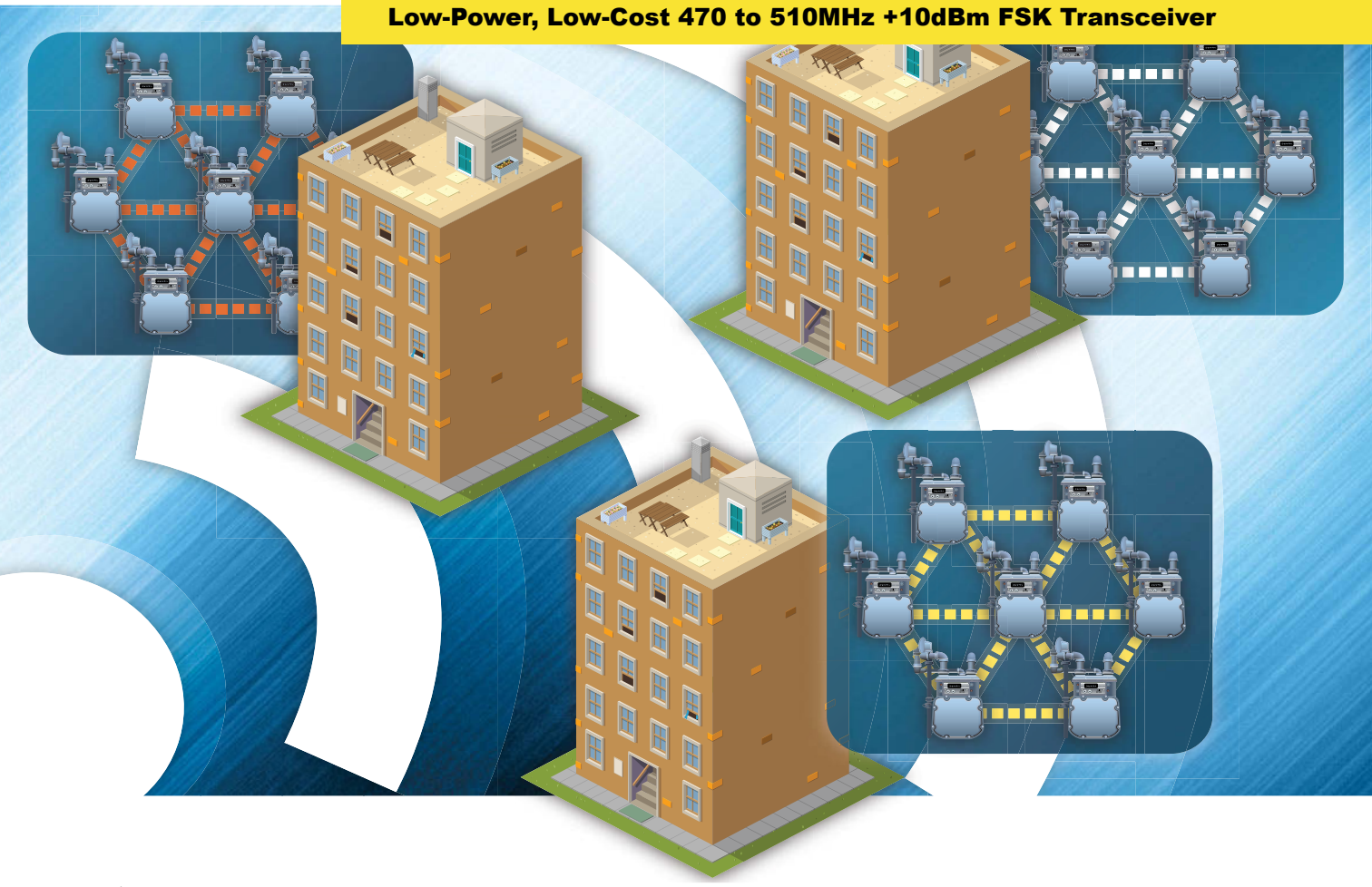

The MICRF507 is the latest addition to Micrel's family of low-cost, low-power, 410 to 950MHz, +10dBm FSK Transceivers and is optimized for the China Short Range Device (SRD) band of 470 to 510MHz. The transceivers combination of excellent 59dB receiver blocking performance, for a low 12mA of receiver supply current, makes it an ideal solution for mesh-based metering applications which require the ability to sense a distant transmitter in the presence of a high blocker. In transmit mode, the transmitter only consumes 21.5mA of supply current from a 2.5V supply, providing excellent efficiency for +10dBm output power. The devices complements and is pin for pin compatible with the MICRF506 (410 to 450MHz) and the MICRF505 and MICRF505L (850 to 950MHz).

For more information, contact your local Micrel sales representative or visit Micrel at: www.micrel.com/micrf507.

Features

- Data Rates up to 200kbps
- -113dBm Receiver Sensitivity at 2.4kbps
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- 12mA Receiver Supply Current
- +10dBm Transmitter Output Power at 21.5mA from 2.5V
- 0.2µA Power Down Current
- FSK Digital Demodulator and Clock Recovery
- Frequency Error Estimator
- 5mm x 5mm 32-Pin MLF® Package

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FPGAs support real-time video over IP for broadcast-TV applications

Xilinx has updated its Real-Time Video Engine TDP (targeted-design platform) with the release of an SMPTE (Society of Motion Picture and Television Engineers)-2022 intellectual-property core. The VSF (Video Services Forum) and SMPTE developed the SMPTE-2022 broadcast-industry standard to standardize IP (Internet Protocol) encapsulation of MPEG (Motion Picture Experts Group) video/audio signals with robust error correction for IP networks. Designers can use the SMPTE-2022 with Virtex-6 or Spartan-6 FPGA broadcast-connectivity kits to process high-quality video at transmissions rates as high as 10 Gbps.

The Real-Time Video Engine TDP comprises a broadcast-quality video- and image-processing IP pack, as well as reference designs for the Virtex-6 and Spartan-6 FPGAs.

The TDP comprises a broadcast-quality video- and image-processing-intellectual-property pack, as well as reference designs for the Virtex-6 and Spartan-6 FPGAs. You can use the TDP to develop a real-time video-processing chain for broadcast applications that support various SD (standard-definition), HD (high-definition), and 3-D formats, frame rates, and resolutions.

The kits provide FMC (field-programmable-gate-array-mezzanine-card) connectors that you can use to quickly evaluate and integrate SD, HD, and 3G-SDI (3-Gbps serial-digital interface); AES3 (Audio Engineering Society) audio; DVI (digital visual interface); HDMI (high-definition multimedia interface); DisplayPort; 10-GbE (gigabit Ethernet) for video over IP; and other interfaces.

The video- and image-processing pack sells for $3000 and will be available at the end of this month. The kits include multiple Xilinx LogiCore intellectual property. The SMPTE-2022 core will be available in the fourth quarter of 2011. A version of the TDP for the company's 7-series FPGAs will debut next year. **—by Mike Demler**

▷**Xilinx**, www.xilinx.com.

Complexity of electronic faucets provides haven for germs

About two years ago, Johns Hopkins Hospital installed electronic hands-free faucets to both save water and reduce recontamination on the hands of hospital personnel. However, a team of researchers at the hospital conducted studies in two wards that examined bacterial growth from 20 manual faucets and 20 electronic faucets receiving water from the same source (Reference 1). Cultures show that 50% of the electronic faucets, compared with 15% for manual faucets, were growing Legionella species, the motile aerobic, rod-shaped, gram-negative bacteria that thrive in central-heating and air-conditioning systems and can cause Legionnaires' disease.

The problem with the electronic hands-free faucets, which rely on an infrared sensor to detect the proximity of hands, is that the faucets have a more complex valve system than do hand-operated faucets. Relying on a garden-variety water-faucet valve to gate the entire flow of water would require much more electrical power than is available to electronic faucets, which typically use battery power to operate the electric eye and valve. In electronic faucets, in contrast, the sensor signal controls a small valve that uses water pressure to amplify the signal and gate the water on and off. These valves are more mechanically complex than those in manual faucets, and although the hospital periodically flushes the pipe with chlorine dioxide, the nooks and crannies within the valve system provide safe harbors for bacteria.

The results don't mean that you should avoid electronic faucets in airports or your workplace bathroom: The bacteria levels are beyond the allowable limits for a hospital; however, they are within spec for general public areas. Exposure to Legionella is dangerous for the chronically ill because it can result in pneumonia for people with compromised immune systems; levels at the hospital were within the level that the general public can tolerate.

On the other hand, do airports and office spaces periodically flush their pipes with chlorine dioxide? Public bathrooms are creepy enough without inspiring a mental image of what's going on inside their pipes.

—by Margery Conner

▶**Johns Hopkins University**, www.jhu.edu.

REFERENCE

1 March, David, "Electronic faucets hinder, not help, hospital infection," *The JHU Gazette,* April 4, 2011, http://bit.ly/dX0E92.

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ANALOG DEVICES

BY HOWARD JOHNSON, PhD

The sound of progress

The field of electrical connectors has enjoyed constant improvement ever since 1903, when US inventor Harvey Hubbell submitted patent No. 774,250 for the first "separable attachment-plug" (**Reference 1**). Connectors today are smaller, carry more current, work to higher voltages, and operate at significantly higher frequencies than their distant cousins—crucial to the operation of high-speed digital backplanes.

From 2001 to 2011, the maximum operating speed of the connectors in leading-edge backplanes improved by a factor of eight (**Table 1**). In 1980, users could employ the VMEbus (Versa Module Eurocard bus) DIN 41612 connector at 100 Mbps when the bus was in differential mode with an appropriate number of ground pins to control crosstalk. The numbers in the **table** imply a doubling of operating speed approximately every four years.

Over the same decade, the number of instructions per second that a leading-edge microprocessor could execute increased from 1000 MIPS (millions of instruction per second) in 2000 to 30,000 MIPS in 2010—a factor of 30. Backplane connectors aren't keeping up. Each year, they fall further behind, and that failure complicates your ability to design fast, reliable systems.

In 1980, when the VME backplane artchitecture reigned supreme, typical digital-system designers did not model backplane connectors. Beyond establishing a signal-to-ground ratio to control crosstalk, the other electrical imperfections in a backplane connector remained less significant than the ribbon cables, unreferenced traces, and IC packages then available. Today, the situation is reversed. A backplane connector and its associated PCB (printed-circuit-board) vias now contribute more signal degradation than almost any other factor. Leading-edge-serial-link designers now routinely attempt a complex co-design of the connector and its attachment along with all other system components.

Unfortunately, the design of any physical system becomes substantially more complex as you push up against the ultimate theoretical limits of its performance. The key to making inexpensive, reliable systems is to identify the primary limit on performance and find a way around it, rather than attempting to scale what may turn out to be a sheer cliff.

Size is the dominating factor that influences backplane-connector performance: The smaller the connector, the better it works in a high-speed application. Yet, over the last decade, the size of backplane connectors has changed little, almost not at all in comparison with the enormous improvements in on-chip geometry. Witness the key metric of connector size in **Table 1**: the effective connector pin density. It has remained practically constant for 30 years.

Why have backplane connectors not shrunk as everything else in the world of electronics has? Backplane connectors do not suffer limits to performance from lithographic constraints, as silicon does. The connector pins are thousands of times larger than silicon. Backplane connectors do not suffer ergonomic considerations, as do other interconnection systems, such as HDMI (high-definition multimedia interface), whose minimum size depends on the ability of a typical user to see and operate the connection. Backplane connectors find their seats automatically with the help of card guides and alignment pins.

Backplane connectors have failed to shrink because of the physical scale of the vias and breakout patterns on the PCB underneath the connectors. They control the overall size of a backplane connector. If you shrink the vias and the connectors, performance will skyrocket. Unfortunately, the 19th-century electrochemical process we still use to make vias and pads improves at a maddeningly slow pace. EDN

TABLE 1 PIN SPACING OF HIGH-SPEED CONNECTORS

Year	Product	Density (pair/mm²)	Rated speed (Gbps)
2011	FCI Airmax VSe	0.119	25
2008	Amphenol Xcede	0.101	20
2008	Ernie Ermet Zd Plus	0.089	20
2007	Molex I-Trac	0.073	12.5
2005	FCI Airmax VS	0.119	12.5
2001	Ernie Ermet Zd	0.089	3.1
1980	VMEbus DIN 41612	0.155*	0.1

*single-ended signals

REFERENCE

1 Hubbell, Harvey, "Separable Attachment-Plug," Patent No. 774,250, United States Patent Office, Nov 8, 1904, http://bit.ly/dQhHaD.

Howard Johnson, PhD, will speak about high-speed connector performance during the EMC 2011 symposium in Long Beach, CA, which takes place Aug 14 to 19.

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IMPLEMENTING AND COMPARING VIDEO OVER USB

ASCENDANT USB 3.0 CAN PLAY A ROLE IN THE VIDEO-TRANSPORT DOMAIN, BUT IT WILL NEED TO SHARE THE STAGE WITH AT LEAST TWO OTHER INTERFACE CONTENDERS: HDMI AND DISPLAYPORT. ALL THREE HAVE MERITS THAT COMPEL THEIR USE IN DIGITAL LIVING ROOMS, PCs, AND MOBILE ELECTRONICS.

BY SONIA GANDHI AND ASHWINI GOVINDARAMAN • CYPRESS SEMICONDUCTOR

HDTV (high-definition television) changed the world forever by recalibrating consumers' expectations of their digital-media experiences. Content creation and consumption are now reaching a pivotal transition point; it is no longer sufficient to view only television shows and movies in stellar high-definition quality. With more than 600 million users now connecting to some form of social media, user-generated content is a significant source of video traffic, with applications such as YouTube and Facebook becoming pervasive.

As users become increasingly mobile, they expect the same quality, performance, and accessibility of content while on the go. They want to be able to watch videos, chat using a webcam, or watch a downloaded HDTV show with a faster and richer user experience. These multiple trends call for a convergence toward a common easy-to-use, portable interface that is flexible enough to provide a connectivity link for all types of media across a variety of applications.

USB (Universal Serial Bus) immediately comes to mind as a user-friendly option that allows universal connectivity. The evolution to USB 3.0 further strengthens its case as the video-connectivity interface of choice (see **sidebar** "Intel Thunderbolt I/O technology").

WHY VIDEO OVER USB?

USB 3.0 provides for a signaling rate of 5 Gbps over a dual-simplex differential-signaling interface. This high-bandwidth capability makes it an ideal choice for video transport. After accounting for protocol overhead due to 8b/10b encoding, the raw throughput over USB 3.0 is approximately 500 Mbytes/sec, enabling reliable transport of 1080p (1920×1080-pixel,


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Figure 1 As webcams become increasingly integrated within laptop and desktop computers' displays, USB-tethered discrete cameras are finding use with TVs.

progressive-scan) video at a 120-Hz refresh rate. The bandwidth requirement for a 1920×1080p HDTV at a refresh rate of 120 Hz and 10-bit per-pixel data is approximately 2.5 Gbps. The bandwidth requirement for other video applications, such as webcam-to-PC connectivity, is ordinarily lower because webcams typically require only 30-frame/sec rates.

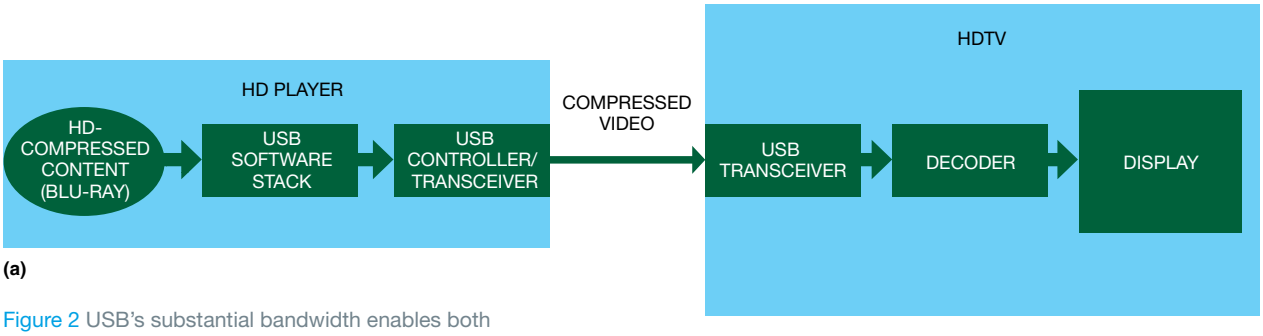
Like USB 2.0, the USB 3.0 protocol supports bulk and isochronous data transfers. The application's requirements dictate the selection of which type of transfer to use. Isochronous transfers offer deterministic bandwidth with a potential trade-off in accuracy and typically find use for video-streaming applications such as webcams. The use of the "streams" model in the new protocol further enhances the high-bandwidth potential of USB 3.0. This model enables transport of multiple streams of data to and from bulk endpoints over a physical USB 3.0 interface. A source can display different content on different devices by sending multiple data streams, which then route to the corresponding devices through a USB hub.

Because the USB interface is agnostic to the data being transferred, USB 3.0 can transport both uncompressed and compressed video. This flexibility allows USB 3.0 to be the interface of choice for productivity applications; HD-video playback; and many other tasks, such as side-loading videos from a PC to a mobile device or streaming video over a webcam (**Figure 1**). The interface can also support audio, which puts USB on par with alternative interfaces, such as HDMI (high-definition multimedia interface) and DisplayPort. Furthermore, USB 3.0 offers enhanced power-management techniques and the ability to transport compressed video, reducing power consumption in mobile devices (**Figure 2**).

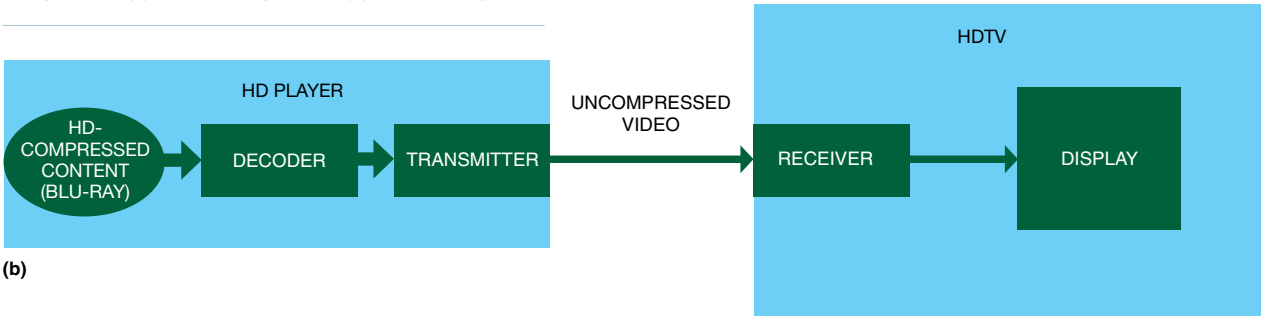
Due to the clear cost advantages of compression, content providers now distribute most 2- and 3-D video content in compressed formats, over either optical physical media or high-speed broadband connections. For example, Blu-ray discs employ several compressed-format options. Interesting usage models, such as connecting a cell phone, a netbook PC, or a tablet computer to one monitor or several larger displays, are also emerging (**Figure 3**). The USB ecosystem can

AT A GLANCE

- USB (Universal Serial Bus) 3.0's 5-Gbps raw signal rate enables it to transport video at high frame rates, resolutions, and color depths.
- Stream support enables a single source to send audio and video content to each of multiple destination devices.
- HDMI (high-definition-multimedia interface) supports uncompressed video transfers on one connection in any format, as many as eight channels of uncompressed audio, and CEC (consumer-electronics-control) data.
- DisplayPort overcomes some of HDMI's limitations by providing an open standard that consolidates internal and external display signaling; it also has sufficient bandwidth head room for future performance scalability.
- Although several advantages exist for connectivity standards such as HDMI in the living room and DisplayPort in monitors, USB has inherent benefits that make it attractive to both markets.



(a)



(b)

Figure 2 USB's substantial bandwidth enables both compressed (a) and uncompressed (b) video transport.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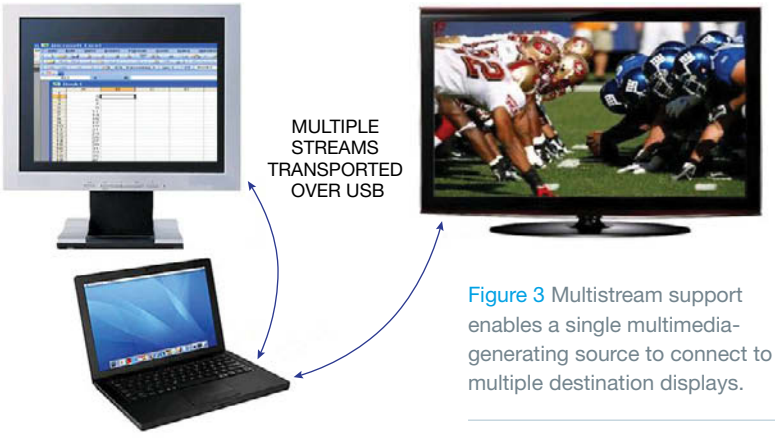

Figure 3 Multistream support enables a single multimedia-generating source to connect to multiple destination displays.

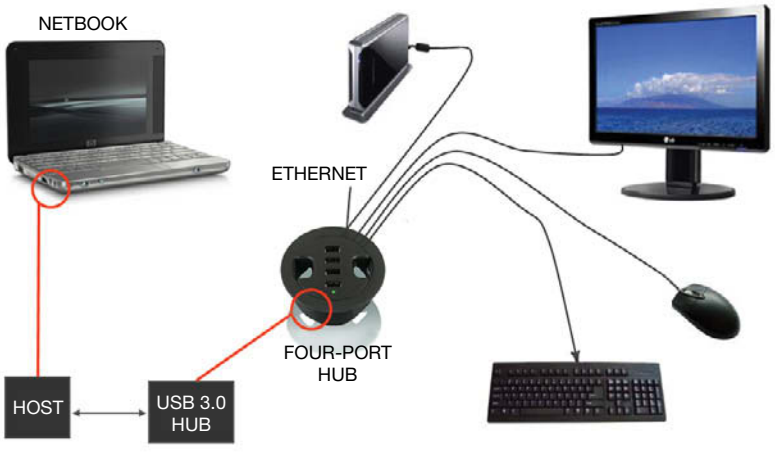

Figure 4 USB's ubiquity and low cost combine to give it the potential to become the universal connectivity interface.

INTEL THUNDERBOLT I/O TECHNOLOGY

Intel's Thunderbolt controllers interconnect PCs and other devices, transmitting and receiving packetized traffic for both PCIe (Peripheral Component Interconnect Express) and DisplayPort protocols. Thunderbolt technology uses data streams in both directions at once, so users get the benefit of full bandwidth in both directions over one cable. With the two independent channels, the technology provides a full 10 Gbps of bandwidth for the first device and other downstream devices.

Dual-channel, 10-Gbps-per-port, bidirectional technology is compatible with DisplayPort devices, allows daisy-chaining of devices, and works with electrical or optical cables. It has low latency and accurate time synchronization, uses native protocol software drivers, and provides power over cable for bus-powered devices.

Thunderbolt enables users to transfer a full-length HD (high-definition) movie in less than 30 seconds and to back up a full year of continuous MP3 playback in slightly more than 10 minutes. With this performance, it should see adoption in high-end applications.

You can license the proprietary Thunderbolt controller, and both the PC and the peripheral side require it. For this reason, the jury is out on whether this interconnect will enjoy widespread adoption. The technology is not an open standard and does not have a large installed base.

enable connecting gaming consoles to a living-room TV without any changes. Adopting USB 3.0 in application segments such as these ones would greatly enhance the usage cases and maintain ease of use.

USB ranks high in consumer adoption and familiarity. It is easy to imagine an extension of the same plug-and-play connectivity interface to media-rich applications, such as downloading HD video from a PC to a mobile device and connecting a PC to multiple display monitors. In addition, you can use the same USB cable to charge the device. However, other well-established incumbent interfaces are in the media room. What benefits do they offer?

HDMI

HDMI is a standard for connecting high-definition products and is an all-digital interface. On one connection, HDMI supports uncompressed video transfers in any format, as many as eight channels of uncompressed audio, and a CEC (consumer-electronics-control) connection. HDMI is also backward-compatible with DVI (digital visual interface).

HDMI supports most audio and video formats and transmits all formats of digital audio and video through one cable, replacing the as many as 13 cables that older technologies require and eliminating cable clutter. HDMI simplifies hooking up other devices to a home-theater system; PCs, gaming consoles, and videocameras can all employ the same one-plug convenience. The HDMI architecture also makes it easy to install or upgrade an all-digital home-entertainment system because all HDMI versions are backward-compatible with previous versions.

HDMI provides a bandwidth capacity of as much as 10.2 Gbps—more than twice the bandwidth needed to transmit an uncompressed 1080p signal. This capability translates into better-looking movies, faster gaming, and richer audio for consumers. HDMI's bandwidth also means that it is ready for emerging technologies, such as 3-D movies; higher-resolution gaming; and support for resolutions higher than 1080p, such as 1440p or Quad HD. The bandwidth head room also allows for higher refresh rates, such as 120 Hz, and deeper color, taking the HDTV palette from millions to trillions of colors.


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TABLE 1 COMPARISON OF DISPLAY/VIDEO STANDARDS

	USB 3.0	HDMI 1.4	DisplayPort 1.2
Raw bandwidth (Gbps)	5	10.2	21.6
Effective bandwidth (Gbps)	4	8.16	17.28
No. of pins	Eight	19	20
Core architecture	Packet based	Digitized component video sent at display-pixel rate (three data pairs)	Micropacket data structure
Clock	8b/10 decoding with embedded clock	Separate reference pixel clock	8b/10b decoding with embedded clock
Interface	Interface is fixed at one dual simplex/ differential pair	Four high-speed differential pairs	One, two, or four differential pairs, depending on bandwidth requirements
Maximum video resolution	4096×2160p24, 16 bits/pixel	4096×2160p24, 36 bits/pixel	4096×2160 at 60 frames/sec, 24 bits/pixel
Connector types	Standard A/B, Micro A/B	Types A, B, C (mini), D (micro), and E	Standard and mini
Charging capability	Yes	No	No
Installed base of core technology for all speeds and revisions	6.5 billion	1 billion	40 million
Auxiliary-channel support	No	Mainly for remote control	Yes
Audio-return channel	Yes	Yes	No
Support for 3-D formats	Yes	Yes	Yes
Hot-plug detection	Yes	Yes	Yes
Daisy-chaining/ multiple-monitor support	Yes	Yes	Yes
Support for Ethernet on the same cable	No	Yes	No
Permitted cable length	3m	Spec defines no length, instead providing specs for cables	15m for video transmission
Support for digital-rights management	In High-Bandwidth Digital Content Protection 2.0	HDMI in High-Bandwidth Digital Content Protection 1.1 and later versions	High-Bandwidth Digital Content Protection 1.3 includes Data Protection 1.1
Compatibility with other standards	Backward compatible with USB	Backward compatible with HDMI	Dual-mode DisplayPort supports single-link HDMI
Royalty	None	Requires royalty to Silicon Image	High-Bandwidth Digital Content Protection

HDMI is a smart two-way connection that allows devices to communicate and interact with each other to improve the overall home-theater experience. Devices connecting using HDMI can scan each other's capabilities and automatically configure certain settings. For example, an HDTV and Blu-ray player can autonegotiate settings such as resolution and aspect ratio to correctly match the format of incoming content to the highest capabilities of the HDTV. CEC provides for integrated "one-touch" commands across multiple linked components. When the manufacturer enables CEC, it allows for systemwide behaviors, such as one-touch play or one-touch record; pressing a button on the remote control launches a series of coordinated commands.

HDMI 1.3 also provides for lip-synch capability, allowing for highly accurate synchronization of audio with the corresponding video. Although HDMI is well-suited for applications in the living room, it falls short for broad applicability to high-performance PC displays due to limitations in scalability and the fact that its primary market focus is on consumer-electronics box-to-box connectivity.

DISPLAYPORT

The VESA (Video Electronics Standards Association) governs DisplayPort, which targets use between a PC and its display, leaving HDMI to focus on consumer-electronics devices and in the living room. VESA intended that DisplayPort would replace VGAs (video-graphics adapters) and DVI. Because all mainstream GPUs (graphics-processing units) and integrated-GPU chip sets now integrate

DisplayPort technology, DisplayPort receptacles are beginning to appear on most new desktop and notebook PCs. DisplayPort overcomes some of the limitations of HDMI by providing an open standard that consolidates internal- and external-display signaling. DisplayPort also has sufficient bandwidth for future performance scalability.

EDP (Embedded DisplayPort) is the new standard for internal-display panels, intending to replace LVDS (low-voltage differential signaling) as the panel interface. The mobile-display interface battle is still ongoing, and DisplayPort is finding use in handheld systems with the introduction of the MDP (Mini DisplayPort) interface. Apple Computer (www.apple.com) introduced MDP in 2008, and it will be competing against USB 3.0 in laptops and small-form-factor communications and computing devices.

DisplayPort's display bandwidth of 17.28 Gbps supports resolution as high as 4000×2000 pixels at 60 frames/sec and 24 bits/pixel. It allows refresh rates as fast as 240 frames/sec for 1080p at 24 bits/pixel and a color depth as great as 48 bits/pixel even at 2560×1600-pixel resolutions at 60 frames/sec. The 5.4-Gbps link rate increases the video-data-stream bandwidth to 2160 Mbytes/sec. DisplayPort handles high frame rates for 3-D gaming applications. DisplayPort 1.1a source devices support the 1080p, 120-Hz performance metric, and this figure could double with DisplayPort 1.2-cognizant source devices. You can also employ DisplayPort to increase TV-display capabilities for PC—especially 3-D—gaming applications.

DisplayPort enables display daisy-chaining, comprehending as many as 63 audio/video streams. The number of monitors it supports depends upon their resolutions, varying from two 2560×1600-pixel WQXGA (wide-quad-extended-graphics-array) monitors to 10 1280×768-pixel WXGA (wide-extended-graphics-array) displays. A TDM (time-division-multiplexing) mechanism supports multiple streams, establishing virtual source-to-sink connections. DisplayPort Version 1.2 also makes available a 720-Mbps auxiliary channel, enabling bulk data transfers over one DisplayPort cable. Applications include USB mass-storage data movement, audio streaming, and camera-to-video transfers.

COMPARING STANDARDS

Although several advantages exist for connectivity standards, such as HDMI in living rooms and DisplayPort in monitors, USB has inherent benefits that make it attractive to both markets (**Table 1**). The key driver for adoption of USB for video is its ubiquity and low cost. USB is available on all PC platforms and almost all mobile platforms (**Figure 4**). It has a larger installed base than any other standard. Using USB to stream video incurs no additional system cost for transport. USB also carries no associated royalty costs, as do other standards.

With the introduction of the new Audio Video class, on which the USB Implementers Forum is currently working, there should be plenty of reasons to switch to USB as the interface of choice. As notebooks become thinner and sleeker, a need will arise for one interface that can support many peripherals, including display and video devices. EDN

AUTHORS' BIOGRAPHIES

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Ashwini Govindaraman is a product-marketing manager in Cypress' USB new-product-development group, where she drives the strategy of the company's consumer-connectivity products. She has held positions at National Semiconductor, Texas Instruments, and Dust Networks in various engineering roles. Govindaraman obtained a bachelor's degree in electrical and electronics engineering from the Birla Institute of Technology and Science (Pilani, India) and a master's degree in business administration from the Wharton School at the University of Pennsylvania (Philadelphia).

RF predistortion STRAIGHTENS OUT your signals

BY PAUL RAKO • TECHNICAL EDITOR

ANALOG OR DIGITAL PREDISTORTION PROVIDES LINEARITY AND EFFICIENCY.

Modern RF amplifiers need both linearity and high efficiency. The linearity requirement is due to the use of modern modulation schemes, such as QAM (quadrature-amplitude modulation) and OFDM (orthogonal frequency-division modulation, **Reference 1**). These amps need efficiency so that they consume less power and reject less heat. Developers often mount modern RF-amplifier assemblies on the antenna pole. These "masthead"-amplifier designs' enclosures can have no fan and are exposed to direct sunlight. Every watt that you can save on power dissipation is a watt that the heat sink need not dissipate. In addition, driving the amplifier too hard will cause it to distort, creating harmonic spurs and ruining your demodulation. These spurs will fall in adjacent frequency bands, perhaps those that cell-phone companies don't own. The FCC (Federal Communications Commission) places strict limits on this ACLR (adjacent-channel-leakage ratio).

Hence, you have two reasons to achieve good linearity: so that you can accurately demodulate the signal and so that your signals don't interfere with adjacent signals. It is also important that you have the best achievable power efficiency in the output stage. The problem is that linearity and efficiency are mutually exclusive.

You can view RF-amplifier distortion in both the frequency and the time domains. You can visualize a rounded-off or flattened sine wave in the time domain passing through

DAN PAGE/THE ISPOT.COM

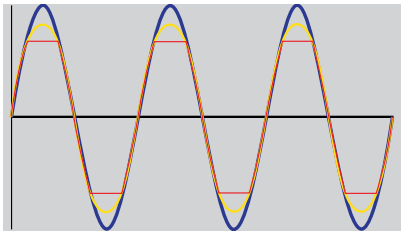

Figure 1 Clipping distortion is apparent when comparing the blue input with the yellow moderately clipped output or the red heavily clipped output waveform. Symmetrical clipping, such as that in this example, appears as odd harmonics in the frequency domain. Amplifier nonlinearity creates intermodulation distortion that is harmonically unrelated to the two input tones.

AT A GLANCE

- RF power amps must be linear.
- Linearity reduces adjacent-channel interference and the bit-error rate.
- Achieving linearity by increasing head room hurts efficiency.
- Predistortion improves linearity and efficiency better than do other methods.
- You can use either analog or digital predistortion to achieve linearity.

the RF amplifier, just like an audio signal that you drive too close to the rails (**Figure 1**). In the frequency domain, amplifier distortion shows up as "skirts" comprising harmonics that lie in adjacent frequency bands (**Figure 2**). The more power you expect from any amplifier, the more distortion you will get. At RF frequencies, you get not only amplitude distortion but also phase distortion and distortion from thermal transients and electrical-memory effects (**Figure 3**). Phase distortion occurs when the RF output lags behind the input signal in the areas of fast slew rates, such as when the carrier signal is passing through ground or when a modulation envelope must instantly move to a different level.

To pack more information into a given bandwidth, modern modulation techniques depend on accurate reception of the envelope of the RF signal. The exact voltage and phase decode a constellation of points that represent a digital code. This code creates a digital data stream that you then further decode into a baseband voice or data signal.

Older modulations are less sensitive to amplifier linearity. AM (amplitude-modulation) radios and analog broadcast TV use AM, which depends on the peaks of the RF signal. Any distortion affects all the peaks equally and has less impact on the quality of the received signal. FM (frequency-modulation) radios and the audio of analog-TV signals use FM, which depends only on the zero crossing of the waveform. Any amplitude nonlinearity has no effect whatsoever. Phase distortions have an effect on the zero crossings, but they tend to be uniform effects and do not interfere with the FM demodulation.

You can use several techniques to improve the linearity of an RF amplifier. First, you can use better transistors. For this reason, manufacturers use GaAs (gallium-arsenide) and other III-V semiconductor processes—chemical compounds with at least one Group III element and at least one Group V element—to make RF transistors. You can also try using SiGe (silicon-germanium) transistors, perhaps in conjunction with a CMOS process (**Reference 2**). Although slower and noisier than GaAs, SiGe can often get the job done, especially at frequencies lower than 3 GHz. Engineers face constant pressure to use CMOS for RF amplifiers—because of its low cost—but the low operating voltage of CMOS makes it difficult to implement in a power amplifier. CMOS also has a high noise factor, which you can reduce by increasing the size of the transistor structures, but that approach also increases the stray capacitance and lowers the frequencies at which you can use the product. RFMD and other companies offer CMOS on sapphire with a dielectric isolation layer under all the transistors (**Reference 3**). This approach exploits the cost advantage and reduces stray capacitance.

The market-driven realities are that engineers can make low-power RF amplifiers in CMOS for Wi-Fi hot spots. Cell phones require more exotic processes, such as SOI (silicon on insula-

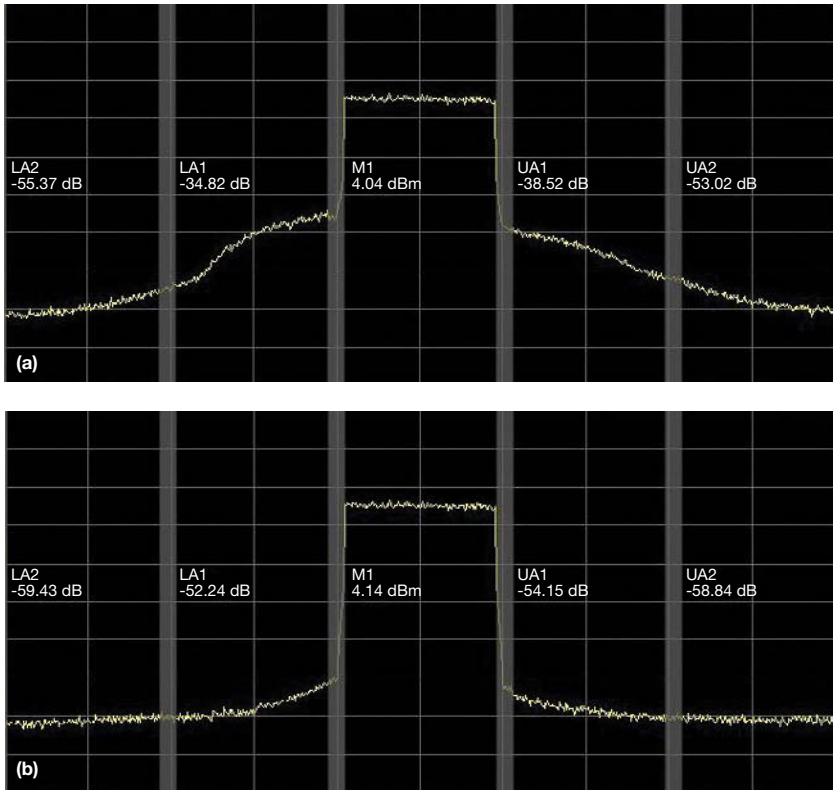

Figure 2 In the frequency domain, distortion shows up as skirts that drape from your intended transmission bandwidth (a). Predistortion schemes reduce those skirts, improving adjacent-channel interference and bit-error rate (b) (courtesy Scintera Networks).

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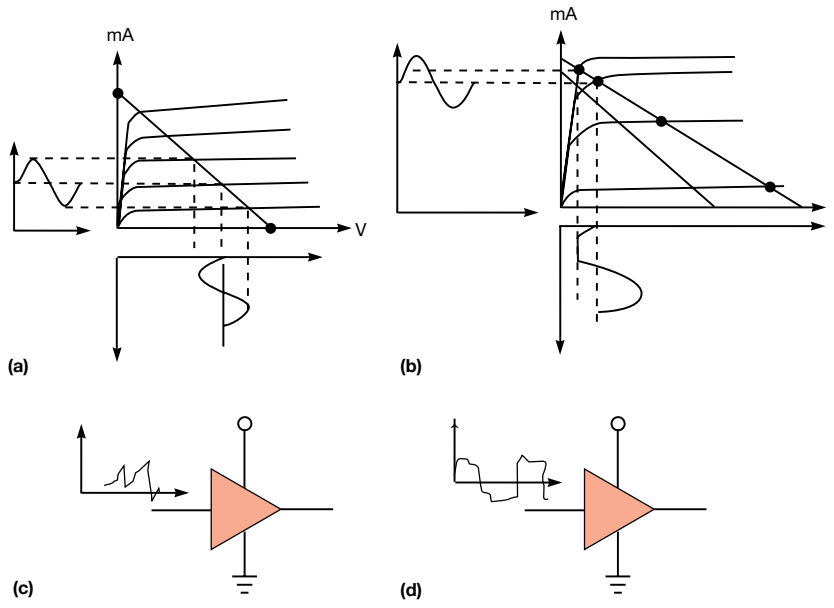

Figure 3 RF-power-amplifier nonlinearity occurs because of the inherent nonlinearity of a transistor amplifier (a), clipping distortion (b), and both electrical-memory (c) and thermal-memory effects (d).

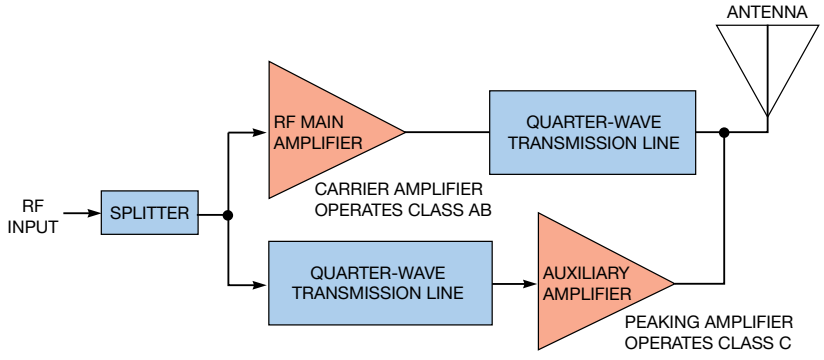

Figure 4 The Doherty RF amplifier achieves better efficiency by using an auxiliary amplifier to vary the load impedance on the primary amplifier. This approach allows the primary amplifier to continue to swing a large signal, dissipating less power in the amplifier. If the auxiliary amp lowers the load impedance on the primary amplifier, the primary amplifier delivers more power.

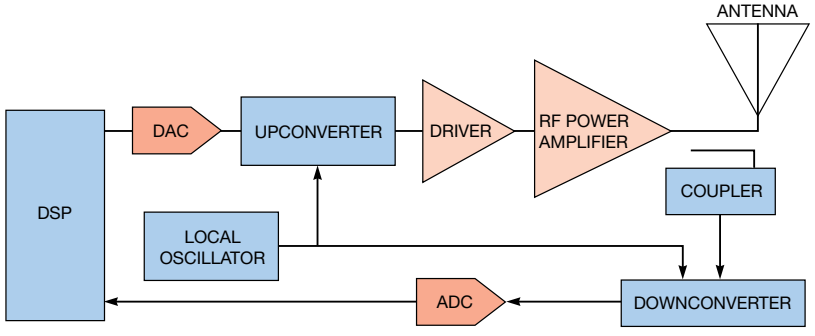

Figure 5 A cell-phone base station uses digital predistortion depending on the components the base station uses. Cartesian feedback also allows dynamic algorithms that can help compensate for memory effects and other nonlinearity.

tor), and GaAs will predominate for the near future in cell-phone base stations.

Once you have a sufficiently linear transistor technology for your power amplifier, you need to look at the amplifier architecture. You can switch from an intermittently driven architecture, such as Class C, to a more continuously driven one, such as Class AB. Class C offers high efficiency because it employs one transistor pulsing a tank circuit to create the RF sine wave you are trying to transmit. Class C amplifiers are woefully inadequate for modern linearity requirements, however, especially in base stations. One way to obtain good linearity is by underdriving the amplifier, so the transistors do not approach saturation and the output-voltage swing is well within the range of the power rails. Unfortunately, this approach is the worst thing you can do for efficiency.

To combat the problem, you can try using a Doherty amplifier, a compound device that uses a main path and a subsidiary RF path to allow you to save power at low signal strengths and still be able to accommodate larger signal swings when you need greater transmitted power (**Figure 4**). Doherty-amplifier architecture works well, but it adds parts and complexity to what ideally is a simple amplifier stage.

Once you push the RF amplifier toward saturation to get efficiency, you can try to linearize it with feedforward techniques. RF designers have for more than a decade successfully used these techniques in cell-phone base stations. The problem now is that the new modulation schemes for 4G (fourth-generation) LTE (long-term-evolution) base stations are even more demanding. To deliver better bandwidth efficiency, measured as bits per hertz, these new modulations put difficult linearity requirements on the best of amplifiers.

This situation has led engineers to use predistortion techniques to linearize RF power amplifiers (**Reference 4**). Because the techniques involve sampling the output of the antenna feed and sending it back to the input, it seems like a familiar feedback technique to all analog engineers. Predistortion provides no feedback signal to an error amplifier, however, because the RF signal moves too fast to send a real-time signal of the carrier frequency back to an error amplifier. Instead, predistortion uses algorithms

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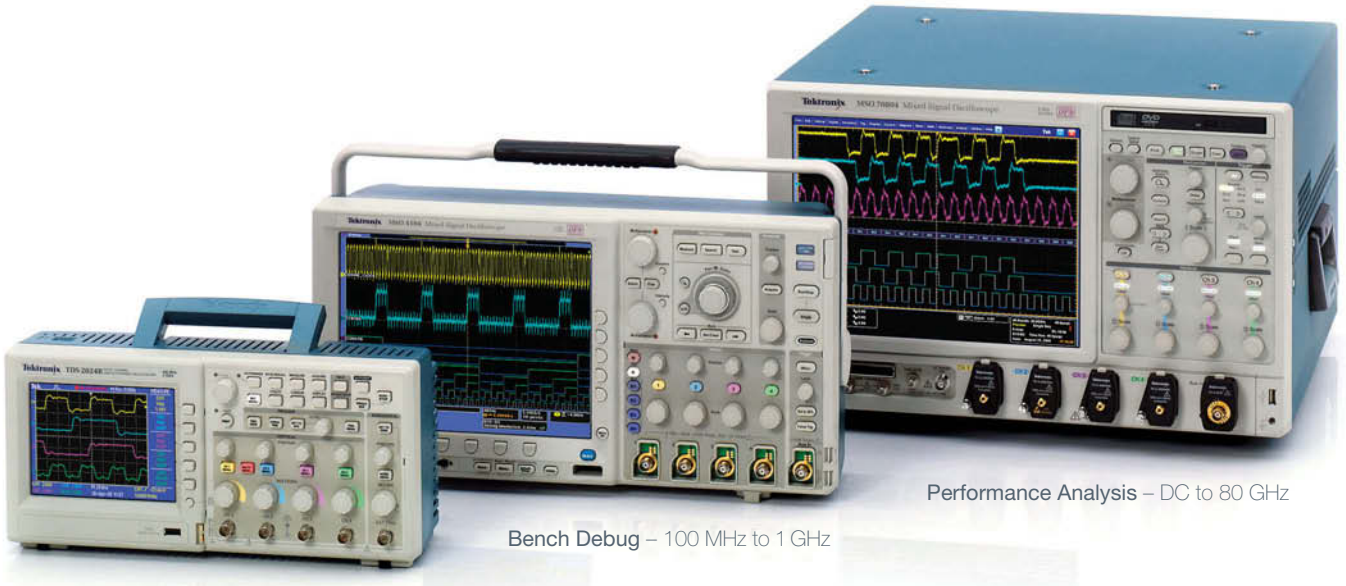

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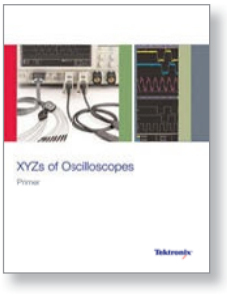

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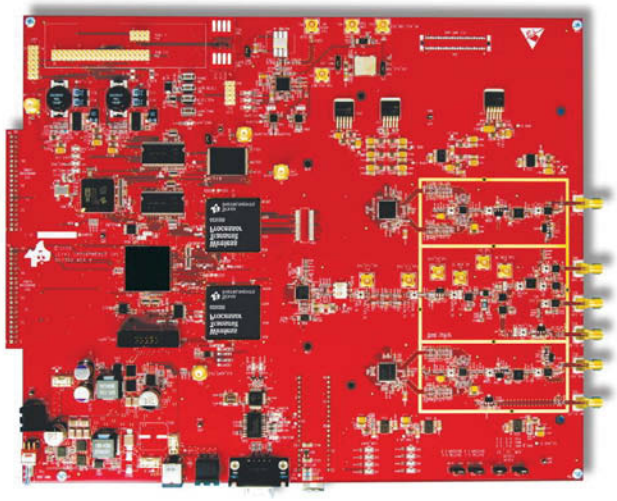

Figure 6 Texas Instruments' demonstration board for the GC5325 predistortion processor includes data converters and demodulators for the RF-signal path.

that accurately predict the effect on various operating conditions of the amplifier to adjust the input signal so that it ends up linear once it passes through the RF power amp.

You can imagine the fundamental contribution of the algorithm. All RF amplifiers flatten a sine-wave carrier that is large enough to swing close to the power-supply rails. So your predistortion algorithm would make these larger-amplitude sine waves have sharper peaks. In that way, you get a purer sine wave from the amplifier. It is easy to visualize this scenario in the time domain. In the frequency domain, you can imagine the predistortion as adding harmonic content at phase angles

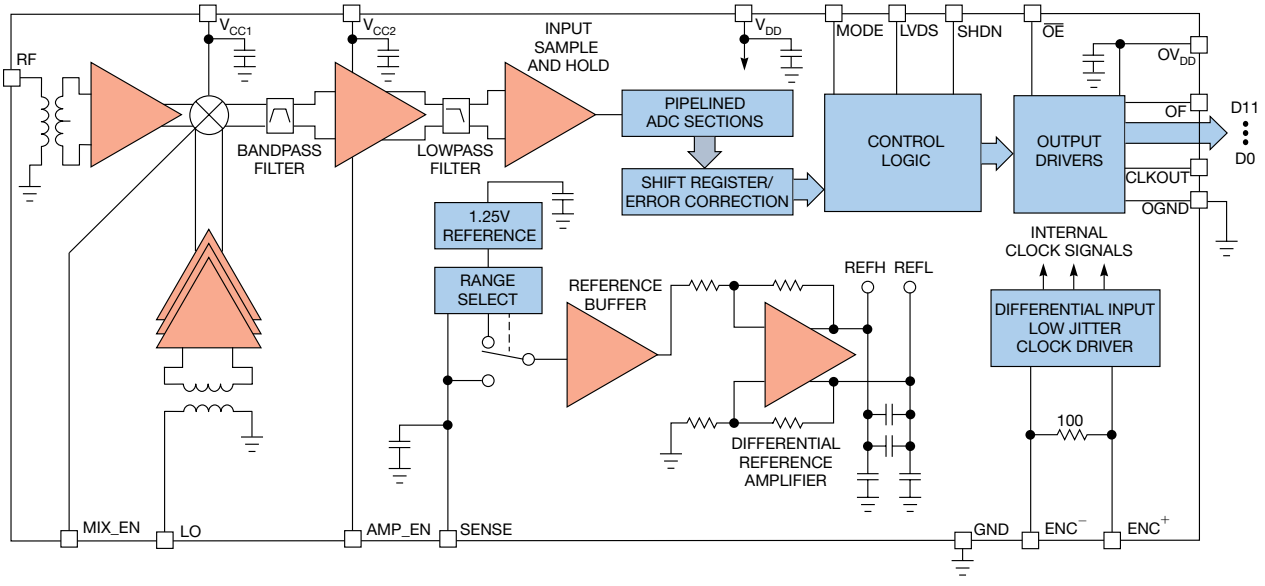

Figure 7 The LTM9003 micromodule from Linear Technology puts the predistortion subsystem in a small package. The part includes internal balanced/unbalanced coupling transformers.

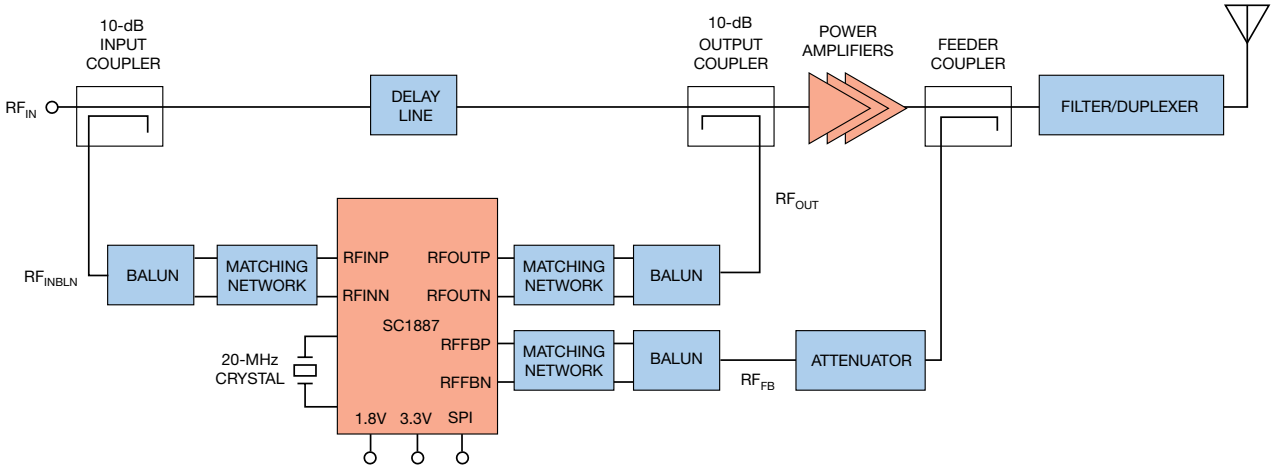

Figure 8 Scintera Networks can correct a power amplifier's nonlinearity using analog predistortion.

that cancel out the spurs that the nonlinear RF power amplifier creates. When you switch on a predistortion circuit, you see the adjacent-channel spurs fall to much smaller amplitudes.

With a similar thought experiment, you can see how a predistortion algorithm can compensate for phase error in an amplifier. Because the phase error is predictable and repeatable, the algorithm can modify the input waveform's timing to null out any amplifier lags. In the time domain, you can imagine the algorithm leading the signal during fast slew rates so that the amplifier ends up outputting a clean sine wave. In the frequency domain, the adjacent-channel spurs fall to acceptable levels.

Modern predistortion algorithms are sophisticated enough to remove distortion even from thermal effects. Hot and cold power transistors distort signals differently. You can develop an algorithm that predicts the power dissipation in the output transistor. From that prediction, you can infer transistor temperature and then adjust the input accordingly to keep the output linear. This algorithm must take into account the thermal time constants of your heat sink and the ambient environment.

DIGITAL OR ANALOG PREDISTORTION?

Over the last few years, cell-phone-base-station makers have accepted the use of digital predistortion to linearize their amplifiers (**Figure 5** and **Reference 5**). In this scheme, a directional coupler samples the RF output. You use a mixer to downconvert the gigahertz-level signal to a lower frequency. You can then use a fast ADC to sample the waveform. You send those samples into an FPGA, which runs the predistortion algorithm you have developed to modify the input waveforms, which a digital data stream also represents. The FPGA can then output the RF baseband or I (index) and Q (quadrature) signals that you upconvert to the RF-carrier frequency of your cell-phone band.

You can use one of several approaches to build this system (**Reference 6**). By sourcing separate ADC and downconverter

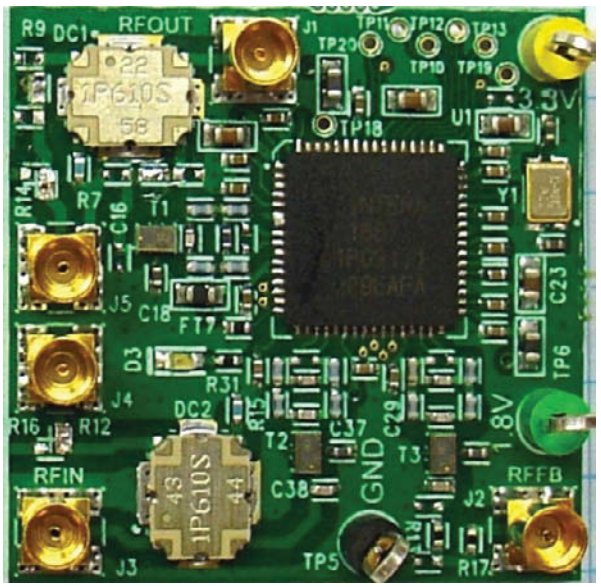

Figure 9 You can observe analog predistortion at work with this Scintera evaluation board.

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chips, you can optimize the system to your needs and use more standardized parts, which you can obtain from many vendors. For example, Hittite, Analog Devices, Texas Instruments, Linear Technology, and Intersil (**Reference 7**) all make the silicon chips you need for a discrete digital-predistortion circuit.

Many engineers are familiar with using Altera's FPGAs in the digital section. The company's megacore IP (intellectual property) performs the digital part of the predistortion operation (**Reference 8**). Analog Devices has partnered with Altera to supply a mixed-signal digital-predistortion system board, and Texas Instruments offers parts such as the GC5325 transmitting processor to reduce signal-crest factor and counteract power-amplifier distortion (**Figure 6**). Xilinx offers a digital-predistortion reference design for its Virtex-4 and Virtex-5 FPGAs. Because cellular base stations are carrying more channels of RF, space is becoming a problem. Companies such as Linear Technology have addressed this problem by incorporating the entire digital-predistortion circuit into the LTM9003 micromodule (**Figure 7**).

Despite cell-phone-base-station manufacturers' acceptance of digital systems, the vendors are making a fundamentally analog circuit into a sampled-data system, bringing cost, power, and space penalties. An alternative is to use analog techniques to linearize your RF amplifier. Start-up Scintera Networks, for example, targets low-power RF systems in the 5W range and in the signal path of UHF (ultra-high-frequency) TV stations (**Figure 8**). The scheme samples the RF from the driver stage and keeps that RF signal in the analog domain, but modifies it with coefficients employing a Volterra Series expansion of the waveform. A Volterra Series is a model for nonlinear behavior that is similar to a Taylor Series, except that the Volterra Series can represent memory effects. Scintera's scheme samples and digitizes the RF output, and that sampling goes into digital circuits in the company's chip. The design uses the digital section to compute the analog coefficients for the RF-signal chain and then uses another directional coupler to mix the Volterra-coefficient-modified RF signal back into the RF path. The system needs to handle only enough RF in the chip to correct the amplifier distortions. Most of the RF power stays in the main RF path, bypassing the IC. By keeping the RF in the analog domain, Scintera provides a system that consumes much less power than does a digital-predistortion setup (**Figure 9**).

Be aware that the design and testing of digital-predistortion systems are not trivial tasks. You will need sophisticated RF-design tools, such as AWR's Microwave Office and Agilent's ADS (**Reference 9**). In addition to advanced test equipment to characterize the RF path, you may need to buy and understand specialized test equipment, such as a real-time spectrum analyzer (**Reference 10**).

No matter if you use analog or digital predistortion, you can reduce interference and use advanced modulation schemes in your RF design. Best of all, the predistortion techniques allow you to drive the RF amplifier closer to saturation, which improves power efficiency. You can roll your own systems from discrete chips or use a micromodule that integrates all of the functions into one package. Achieving the necessary linearity in the ADC and the downconverter ICs is an achievement for the semiconductor companies. These companies all have application experts that can help design an RF-signal path that will meet all of your regulatory requirements, sip power, and deliver the most bits per megahertz. EDN

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RAISE A GLASS:

EDN's 2010 Innovator and Innovations of the Year

Now in its 21st year, *EDN*'s annual Innovation Awards program once again did not disappoint. Following a period of record online voting by *EDN* readers in several closely matched product and technology categories, *EDN* editors joined more than 150 guests during a May 2 cocktail reception in San Jose, CA, to toast the winners. Read more about them here. For additional details on the winners, as well as a list of all of the finalists, visit www.edn.com/innovation21.

ANALOG ICs

EM773 ENERGY-METERING IC

(NXP SEMICONDUCTORS)

The flash-based EM773 ARM Cortex M0 microcontroller has ac-power-metrology functions. It can run a full communications protocol stack and do metrology measurements. The device targets use in energy monitoring for washing machines, server-rack management, and "green" appliances. It does not target use in traditional billing meters. The EM773 performs 11 power-metrology measurements, including active, reactive, and apparent power; power factor; zero-crossing frequency detection; and THD (total harmonic distortion). The measurements are accessible through an easy-to-use API (application-programming interface). An SDK (software-development kit), available at www.nxp.com/smartmetering, includes an open-source example wireless M-Bus-based application.

APPLICATION-SPECIFIC STANDARD PRODUCTS

VDAP1000

(INTEGRATED DEVICE TECHNOLOGY)

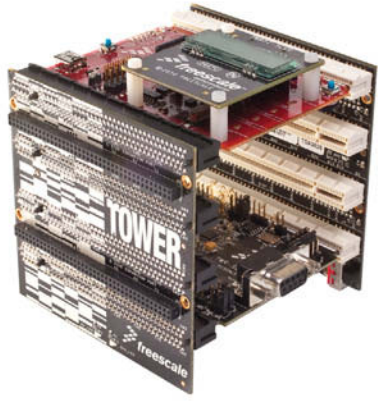
The VDAP1000 is the industry's first single-chip power-management product for TFT (thin-film-transistor) LCD (liquid-crystal-display) panels, such as those for netbooks, tablet PCs, and notebooks. The device integrates a full-function LVDS (low-voltage-differential-signaling) timing controller with fully integrated power management and a four-channel LED driver for LED backlighting, saving power and board space. The VDAP1000 also enables spread-spectrum technology, improving signal integrity and system performance.

DEVELOPMENT KITS, REFERENCE DESIGNS, AND SINGLE-BOARD COMPUTERS

TOWER SYSTEM

(FREESCALE SEMICONDUCTOR)

The Freescale Tower System gives engineers hardware and software tools that let them test-drive embedded products and prototype their embedded-system designs. The modular design and low cost make it easy for engineers to quickly mix and match the modules they need. Freescale offers free online downloads of Tower mechanical specifications; pinout standards; and design-source files, including OrCAD schematics, Allegro layouts, and fabrication drawings, so that engineers can design custom modules or add modules to the commercial Tower System portfolio. To reduce costs, the Tower System uses standard 16-lane PCIe (Peripheral Component Interconnect Express) sockets on "elevator" backplane boards along with PCIe card-edge contacts. The innovative modularity and design of the system let engineers benefit from rapid prototyping and reuse their hardware and software from design to design.



DIGITAL ICs

SMARTFUSION INTELLIGENT MIXED-SIGNAL FPGAs

(MICROSEMI CORP)

SmartFusion integrates an FPGA, a hard ARM Cortex-M3-based microcontroller subsystem, and programmable analog into a single IC. Overcoming the limitations of simple microcontrollers in embedded-system designs, SmartFusion can add hardware acceleration to software processes or provide custom interface logic to other components in the system. The built-in analog provides temperature, current, or voltage monitoring and a variety of sensor inputs. FlashLock technology provides IP (intellectual-property) security. The Libero IDE (integrated design environment), Eclipse-based SoftConsole IDE with GNU, software tools, real-time operating system, OS-III, TCP/IP (Transmission Control Protocol/Internet Protocol) stack, and Probe products from various partners support the SmartFusion family.

EDA TOOLS AND ASIC TECHNOLOGIES

PATHFINDER

(APACHE DESIGN SOLUTIONS)

The PathFinder tool works with standard Spice device models to accurately simulate ESD (electrostatic-discharge)-protection devices. Apache developed the eSim nonlinear transient solver to analyze the negative resistance "snap-back" effect when ESD structures activate, causing convergence problems for traditional Spice simulators. PathFinder also includes a built-in parasitic extractor for RLC (resistor/inductor/capacitor) elements in power and ground buses and the substrate-package interface. The PathFinder tool performs layout-based analysis of circuits with more than 1 million elements for ESD events such as HBM (human-body model), MM (machine model), and CM (charged-device model).

HUMAN-TO-MACHINE-INTERFACE TECHNOLOGY

mTOUCH METAL-OVER-CAPACITIVE

INNOVATORS OF THE YEAR

ROBERT DOBKIN AND TOM HACK (LINEAR TECHNOLOGY)

Accurately regulating a voltage at a load can be difficult when there are significant voltage drops between the power supply and the load. Even if a regulator produces a perfectly regulated voltage at its own output, variations in load current affect the current/resistance drop along the wiring, resulting in significant voltage fluctuations at the load end. Years ago, Bob Dobkin (photo, top), Linear Technology's cofounder, vice president of engineering, and chief technology officer, came across the idea of modulating the output power supply to interrogate the line impedance to correct the voltage at the load. Tom Hack (photo, bottom), a senior design engineer at the company, tried to determine the circuitry necessary to make the idea work. He needed a method to continuously interrogate small signals, provide feedback to correct the line impedance, and dynamically correct for the voltage drops. The two came up with a new control method—VRS (virtual remote sense)—which can sense line impedance without separate sense connections. They designed the LT4180 as a controller that supplements the controller in an IC or a modular power supply.

TOUCH-SENSING TECHNOLOGY
(MICROCHIP TECHNOLOGY INC)

Capacitive touch sensing is gaining traction as an alternative to traditional push-button user interfaces because it enables a completely sealed, modern-looking design at lower cost. Microchip's mTouch metal-over-capacitive touch-sensing technology further builds on the technology's foundation by enabling capacitive touch sensing with metal front panels. This royalty-free technology works through gloves; is waterproof; is operable in environments with radiated noise, conducted noise, or both; and enables Braille implementations for visually impaired users. The mTouch capacitive-sensing technology features an active current of less than 5 µA. Designers can augment their application code with mTouch sensing algorithms on 8-, 16-, or 32-bit PIC microcontrollers.

PASSIVE COMPONENTS, SENSORS, INDICATORS, AND INTERCONNECTS

MT9H004 IMAGE SENSOR WITH DR-PIX TECHNOLOGY (APTINA)

Using the company's DR-Pix (dynamic-response-pixel) technology, Aptina's new high-performance APS (active-pixel-sensor)-C format, 16M-pixel MT9H004 image sensor delivers maximum SNR (signal-to-noise ratio) across all scene lighting and ISO (International Standards Organization)-speed conditions. Through the addition of a pixel-level, DCG (decaliter-conversion-gain) switch, DR-Pix combines an LCG (low-conversion-gain) mode for large-charge-handling capacity in bright scenes and an HCG (high-conversion-gain) mode with increased sensitivity and low read noise for low-light scenes. With the MT9H004 sensor, you can achieve a 5-dB increase in SNR, approximately equivalent to gaining two full F stops of range for the camera-lens aperture, under low-light conditions. You can accomplish this task without sacrificing performance in high-light environments, in which the device can achieve a 47-dB maximum SNR.

POWER ICs

LT4180 VIRTUAL REMOTE SENSE CONTROLLER (LINEAR TECHNOLOGY)

The LT4180 provides tight power-supply output-voltage regulation over long cables. Improving regulation at the load side often involves adding extra wires for remote sensing—a sometimes-undesirable or impossible situation. It is costly to use a remote regulator to maintain voltage at the load. The LT4180 supplements the controller IC or the modular power supply. Using VRS (virtual remote sensing), it compensates for voltage drops at the load without using sensing wires. The IC continuously measures the output line impedance by multiplexing a small ac signal on the output. The capacitor at the remote load effectively shorts this signal. The device can then measure the current associated with this small ac excitation voltage, allowing it to infer the output wiring impedance so that it can continuously correct the power-supply output voltage. The unit drives optoisolators if necessary. It has undervoltage- and overvoltage-lockout protection, soft-start, and a ±1% internal voltage reference.

POWER SUPPLIES

BSV-NANO POL CONVERTER
(BELLNIX AMERICA INC)

The latest FPGAs often require low voltages at high currents and have placed increasingly tough requirements on power supplies. POL (point-of-load) dc/dc converters must provide ultra-high-speed load-transient response, small form factors to allow their placement close to FPGAs, and low voltages at high currents with high conversion efficiency. To address these needs, the BSV-1.8S4R0NA POL converter provides high-speed response using a new control system that differs from a traditional PWM (pulse-width-modulation) control system, an 11×11-mm package, and a low-power-loss switching element. Previous approaches required large decoupling capacitors to decrease circuit impedances; the high-speed-response performance of the BSV-1.8S4R0NA significantly reduces this need. The BSV-nano

POL converter can provide the optimal level of performance for the latest FPGAs in a small space.

PROCESSORS

CORTEX-M4 PROCESSOR (ARM)

ARM developed the Cortex-M4 processor for markets that demand control- and signal-processing capabilities. It extends the Cortex-M processor family by introducing DSP-specific features. Its Harvard architecture simultaneously reads instruction and data from memory, enabling it to perform many operations in parallel. Data registers are 32 bits wide and can alternatively store two 16-bit data samples or four 8-bit samples. With SIMD (single instruction/multiple data), a numeric operation simultaneously applies to two 16-bit or four 8-bit packed-data values. The Cortex-M4 supports various single-cycle MAC (multiply/accumulate) instructions for 16- and 32-bit data; it can even perform two 16-bit MAC instructions in parallel in one cycle. The single-precision FPU (floating-point unit) complies with the IEEE 754 standard. Saturating-math-operation support ensures that, when a value overflows it clips to the largest positive or negative value with no additional cycle-arithmetic overhead.

SOFTWARE

WEBENCH FPGA POWER ARCHITECT (NATIONAL SEMICONDUCTOR)

The Webench FPGA Power Architect accelerates the design and optimization of multiple-load power-supply systems for advanced FPGAs. The tool incorporates the detailed supply requirements of more than 150 FPGA devices from Altera, Xilinx, Actel, and Lattice. After selecting the desired FPGAs and adding loads, you can compare system topologies using one or more intermediate voltage rails and compare system options using graphs to visualize the best approach for a user's goals. You can also order components for prototyping in Webench FPGA Power Architect; share the system with others; or print a project report.

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PXI AND AXIE TEST PORTFOLIO (AGILENT TECHNOLOGIES)

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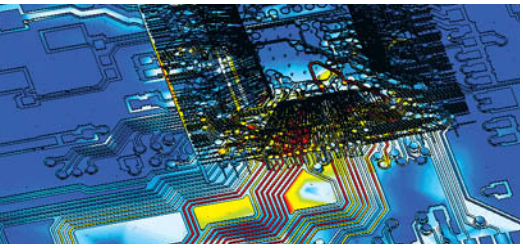

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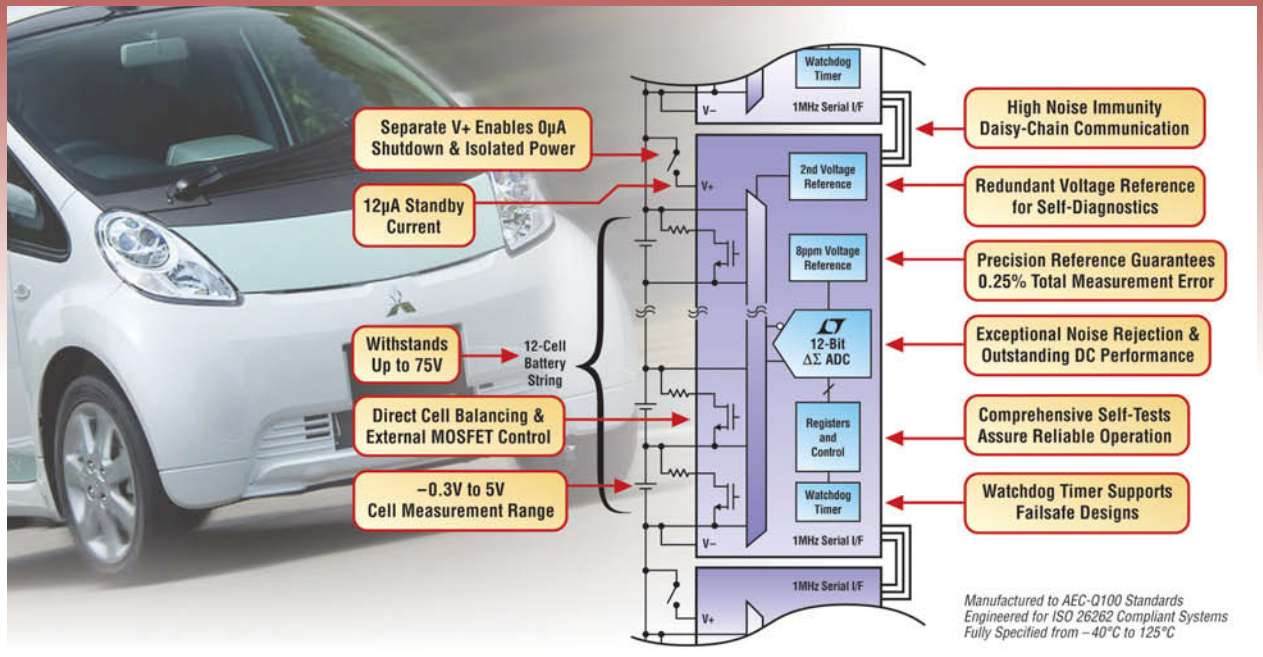

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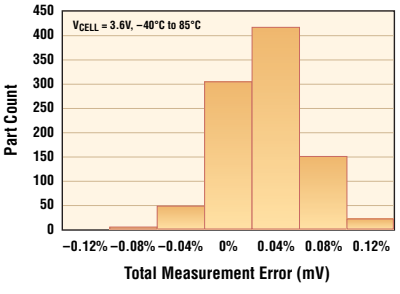

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Circuit secures bootstrap operation under light load

Chee H How, Kuala Lumpur, Malaysia

A previous Design Idea highlights a potential issue of a bootstrap IC under light-load or precharged-load operation (**Reference 1**). The circuit in **Figure 1**, with the additional circuit in the green box, fixes the problem of a voltage dip in the bus-voltage signal. The waveforms in **Figure 2** demonstrate how this problem takes place in buck converter IC_{1B} when its output voltage, V_{BUS}, dips below the regulation point at a fixed rate under no load. By inspecting the other traces in **Figure 2**, you can conclude that the dip of V_{BUS} occurs when the bootstrap voltage falls below its threshold of 8.66V (Trace 3), causing the buck converter's switching action to cease. This situation intensifies when the bus voltage approaches the input voltage.

During freewheeling operation of DCM (discontinuous-conduction mode), the output signal (**Figure 3**, Trace 4) tends to settle at the bus voltage after inductor L_1 completely discharges. This action prevents bootstrap

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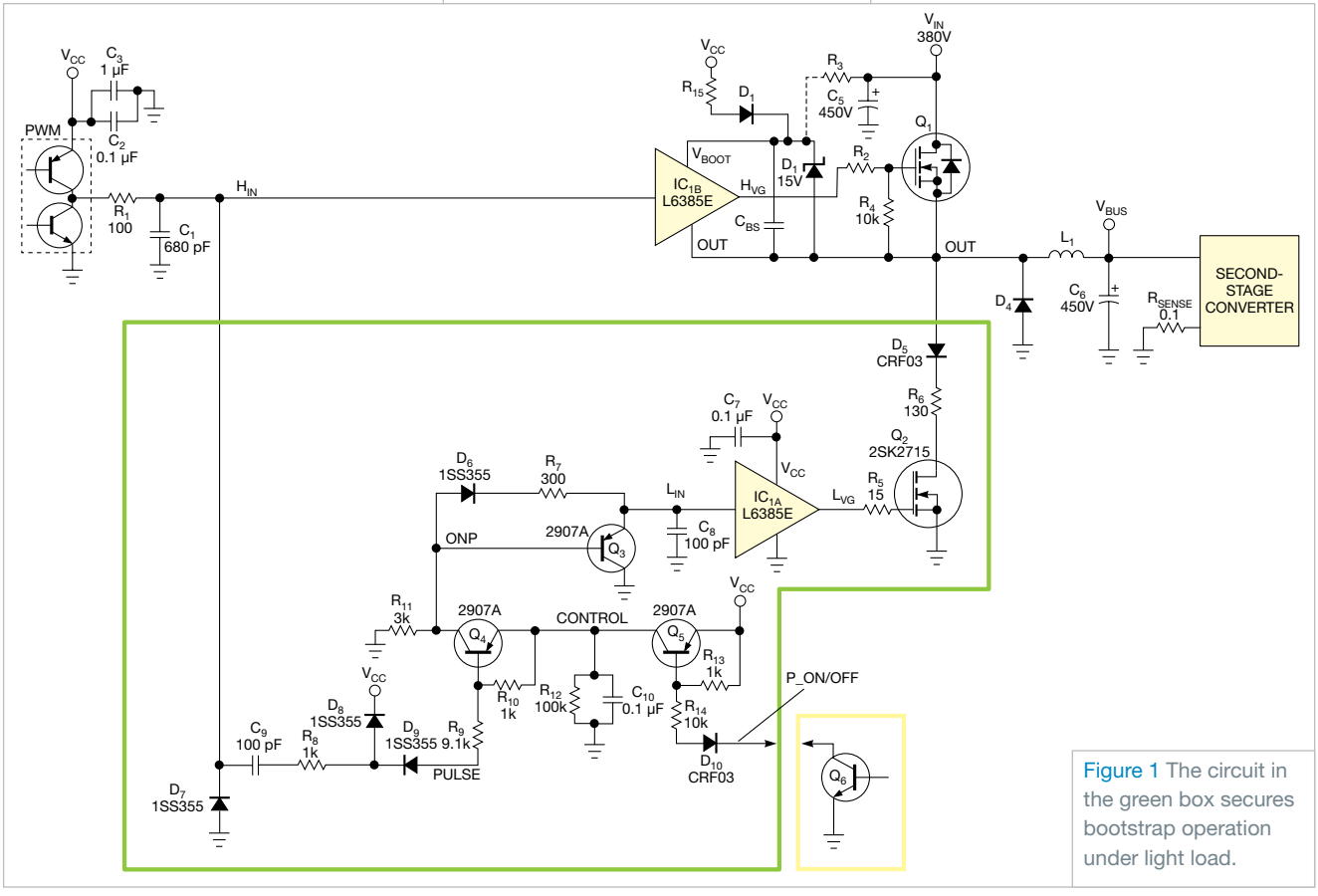

Figure 1 The circuit in the green box secures bootstrap operation under light load.

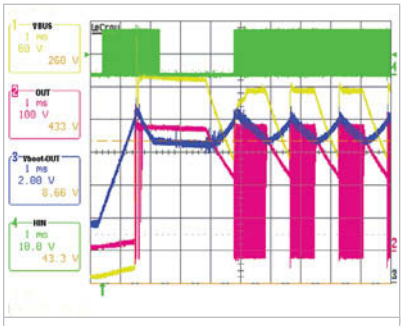

Figure 2 A 380V-dc buck converter suffers from output dipping under no-load conditions. Trace 1 is the buck converter's output voltage; Trace 2 is the switching-node voltage; Trace 3 is the voltage across the bootstrap capacitor, V_{BS}; and Trace 4 is the input signal to the bootstrap's high-side driver, H_{IN}.

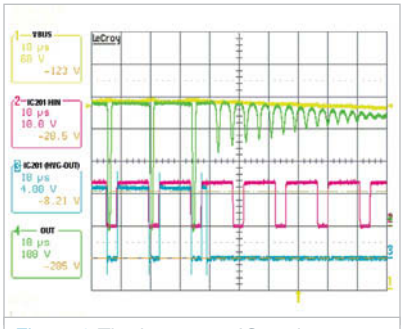

Figure 3 The bootstrap IC undergoes premature termination under no-load conditions. Trace 1 is the buck converter's output voltage, V_{BUS}; Trace 2 is the input signal to the bootstrap's high-side driver, H_{IN}; Trace 3 is the high-side output of the bootstrap driver, V_{OH}; and Trace 4 is the switching-node voltage, OUT.

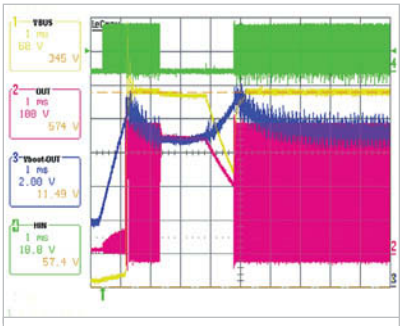

Figure 4 With Figure 1's subcircuit at a no-load condition, Trace 1 is the buck converter's output voltage, V_{BUS}; Trace 2 is the switching-node voltage, OUT; Trace 3 is the voltage across the bootstrap capacitor, V_{BS}; and Trace 4 is the input signal to the bootstrap's high-side driver, H_{IN}.

capacitor C_{BS} from charging, which eventually causes the bootstrap voltage in **Figure 2** to fall below 8.66V. Hence, the buck converter stops switching.

The circuit in **Figure 1**'s green box aims to solve the problem. It starts by tapping the input signal to the bootstrap's high-side driver to generate an inverted and delayed short pulse to control Q_2. Upon activation, Q_2 forces the output signal momentarily low, which provides an opportunity for C_{BS} to charge. R_8, R_9, R_{10}, R_{11}, and C_9 set the turn-on period of Q_2. This period must not exceed the dead time of the PWM (pulse-width-modulated) signal. If Q_2's turn-on time is too long, the converter's efficiency will degrade, or the C_{BS} might not sufficiently charge. Inadequate charging of Q_2 involves multiple component values and operating parameters, such as Q_2's turn-on time, and you might have to empirically tune the delay time to accommodate for these effects. The values in **Figure 1** produce a Q_2-turn-on time of 1 µsec and delay time of 450 nsec in a 70-kHz switching frequency.

The Q_5 network is optional. It lets you disable operation of Q_2 when it is not necessary by linking the P_on/off signal to an open collector, Q_6. The low section of IC_{1A} drives Q_2. You must experimentally select the value of R_6. A resistance value that is too low induces larger current spikes upon activation of Q_2. On the other hand, a resistance value that is too high causes C_{BS} to insufficiently charge.

Resistor R_7 and capacitor C_8 control the delay time between the falling edge of the input signal to the bootstrap's high-side driver and the rising edge of IC_{1A}'s LVG (low-voltage) pulse. **Figure 4** displays the waveform of the same converter after the inclusion of the additional circuit. In this case, V_{BUS} (Trace 1) remains stable and the output signal from the buck regulator switches continuously, lacking the gaps with switching that the waveforms of **Figure 2** show. EDN

REFERENCE

1 Larson, Justin, and Frank Kolanko, "Buck regulator handles light loads," *EDN*, Sept 9, 2010, pg 48, http://bit.ly/eVbMdP.

Build an accurate bipolar voltage reference

Marián Štofka, Slovak University of Technology, Bratislava, Slovakia

Pulse generators often need voltage comparators with accurately defined hysteresis, and such comparators need bipolar voltage references. Most voltage-reference-cell ICs are referenced to their low-side supply rail. If your circuit needs both positive and negative voltages, you could create the negative reference voltage by connecting a –1 gain inverter to the output of an IC reference cell. If your analog circuit runs from a single power supply, however, you must shift the common-mode voltage to a specific level. You can use the circuit in **Figure 1** for that task.

Reference cell IC_1's output voltage, V_{REF}, connects to the noninverting input of amplifier IC_2, an AD8475. This high-precision, differential-output, ×0.4/×0.8 amplifier in this case connects as an ×0.8 amplifier (**Reference 1**). The negative input, –IN, of IC_2 is grounded. Voltages at its positive and negative outputs form the positive- and negative-output reference voltage, referenced to common-mode voltage V_{COM}. The magnitude of the generated reference voltages is $(1/2)\times0.8\times V_{REF}=1V$.

The AD8475's gains of 0.4 and 0.8 have a tolerance of no more than 0.05%

because of the device's laser-trimmed internal gain-setting resistors. This circuit takes advantage of the AD8475's gain-setting options. Typical use of the device as a ×0.8 amplifier keeps the +VIN0.4× and –VIN0.4× unconnected. In the circuit in **Figure 1**, however, these inputs interconnect, forming a high-precision 1-to-1 voltage divider of V_{REF}.

The V_{COM} input of the AD8475 connects to this node, and the common-mode voltage of the generated reference voltages becomes $V_{REF}/2$. Case A in **Table 1** shows that the measured common-mode voltage is approximately 0.6% lower than $V_{REF}/2$. This difference stems from the fact that the V_{COM} input connects within the AD8475 through one 200-kΩ resistor to the V_S pin and through another 200-kΩ resistor to ground. You can, therefore, model the V_{COM} input as a source of $V_S/2$=2.5V with a series resistance of 100 kΩ. This series resistance acts as if it connects in parallel to the $R_{+VIN0.4×}$ resistor, which results in a slight imbalance in the 1-to-1 divider ratio. In cases B and C, the V_{COM} pin connects to Point A. The compensation resistor connects only in Case C. You can prove from the V_{GND} values in cases B and C that R_{COMP} pushes the relative error of voltage at the COM output from 0.632% to –0.032%.

In many applications, the magnitude of difference of bipolar reference voltages is important, and this imbalance has no effect on it. If, however, your application requires a high-accuracy common-mode voltage, you can connect a 100-kΩ compensation resistor between the V_{COM} pin and ground, and the circuit thus operates as in Case C. This approach almost fully retains the accuracy of the 1-to-1 divider ratio. EDN

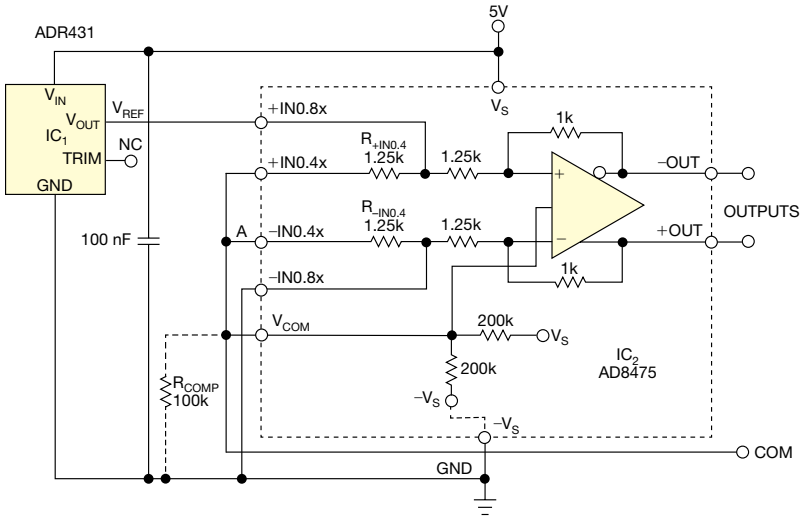

Figure 1 You can use this circuit to generate precision reference voltages of 1, –1, 1.25, and –1.25V.

TABLE 1 OUTPUT VOLTAGES AND VOLTAGE AT V_{COM} PIN

	Case A	Case B	Case C
Positive-output voltage (V)	2.2525	0.9981	0.9986
Negative-output voltage (V)	0.2525	–1.0019	–1.0011
Ground voltage (V)	–1.25	–1.2579	–1.2496
Common-mode voltage at V_{COM} pin (V)	1.239	0	0

REFERENCE

1 "AD8475 Precision, Selectable Gain, Fully Differential Funnel Amplifier," Analog Devices, http://bit.ly/gOtm7G.

Send MIDI signals over long distances

Miguel Ratton, Informus Music Center, Parana, Brazil

The MIDI (Musical Instrument Digital Interface) protocol transfers digital control messages among synthesizers, audio equipment, and computers. A consortium of hardware and software manufacturers in 1983 developed the MIDI standard, which defines the use of microphone cables to link devices at a maximum distance of approximately 20m. That length may be insufficient for controlling distant devices. For example, in some venues, the equipment is on stage and you may want to send control messages from a remote mixing board.

The circuit in **figures 1** and **2** uses line drivers and receivers that let you transfer MIDI data signals over a common Category 5 LAN cable. MIDI data comes from the MIDI transmitter device and passes through optocoupler IC_1, conforming with the MIDI standard because it provides isolation between the devices.

Figure 1 You can test the completed MIDI drivers with a 100m Category 5 cross cable.

The MIDI signal then goes to the UA9638C line driver, which transforms

the data from a single-ended signal to a differential signal suitable for transmission over the Category 5 cable. The transmission passes through one of the pairs of a cross cable, reaching the UA9637C line receiver in an equal circuit on the other end. The signal then reformats to TTL (transistor-transistor-logic) level and travels through a MIDI output to reach a MIDI receiver device. LEDs D_2 and D_3 show the transmitter/receiver activity. Tests prove that this circuit can transfer messages over distances of more than 100m without losing data. EDN

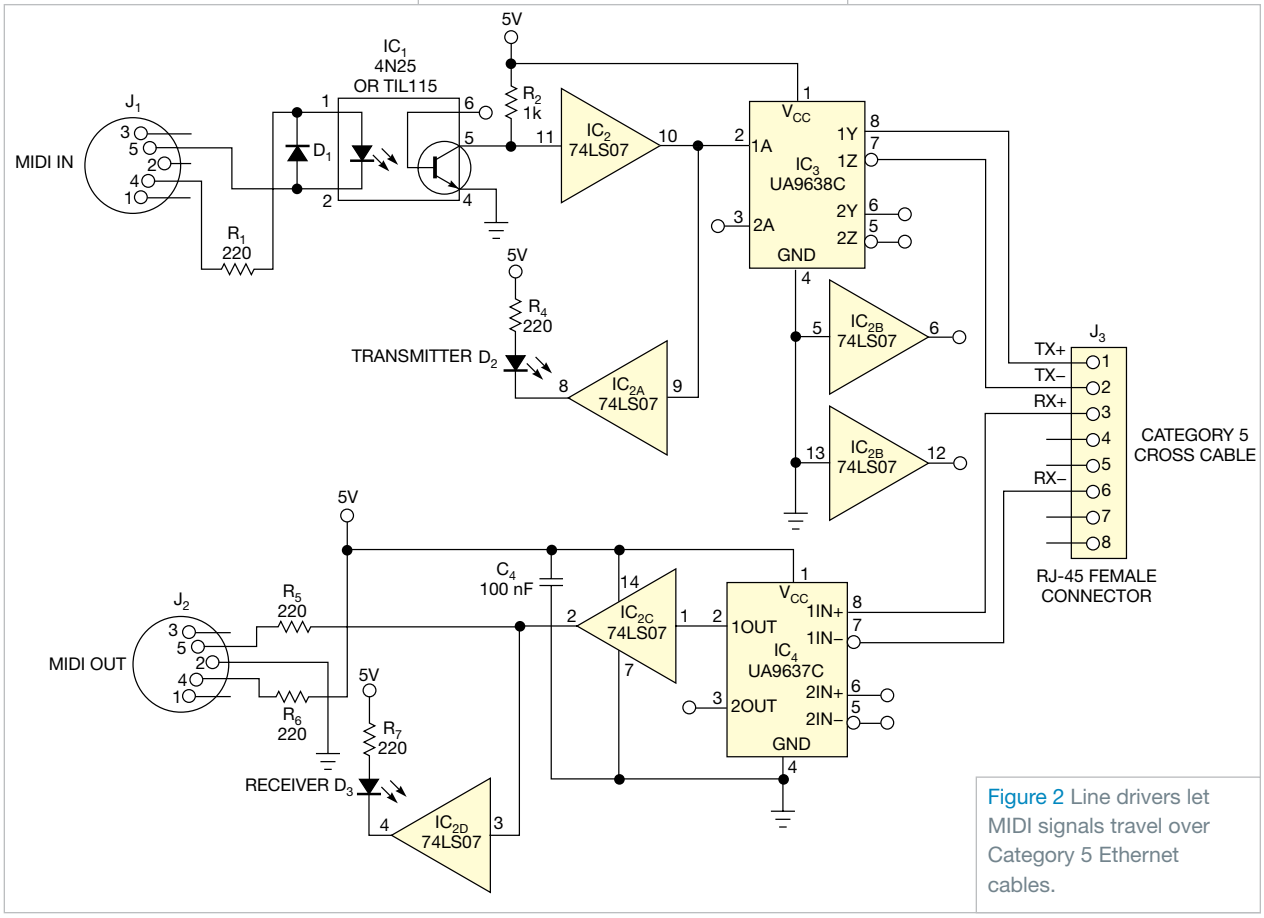

Figure 2 Line drivers let MIDI signals travel over Category 5 Ethernet cables.

MOSFET provides high power at low loss

Camilo Quintáns Graña and Jorge Marcos Acevedo, Vigo University, Vigo, Spain

PN-junction diodes often have a dropout voltage of approximately 1.2V for silicon power diodes. That voltage drop causes power diodes to dissipate considerable power, resulting in a loss of efficiency in a power supply. In a photovoltaic panel with 120W of power and 24V nominal voltage, an antireturn diode may cause a power loss of 6W, or 5% of the managed energy. Moreover, the cost of developing a cooling system for dissipating the heat diodes may pose a problem.

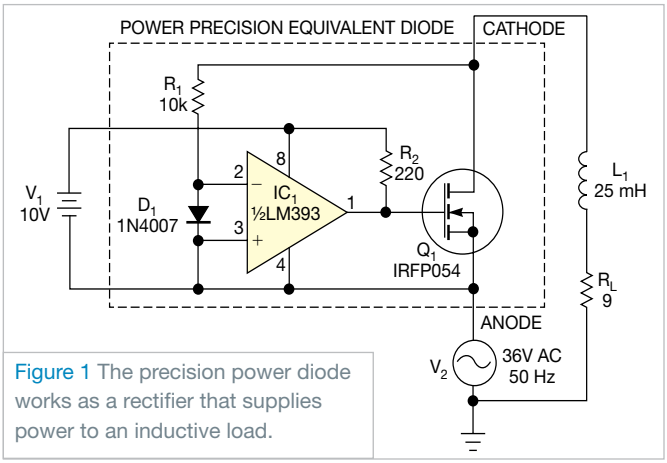

Figure 1 The precision power diode works as a rectifier that supplies power to an inductive load.

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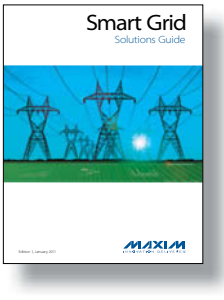

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This Design Idea shows a more efficient approach that replaces a conventional power diode with a MOSFET transistor operating in on/off mode. **Figure 1** shows the rectifier circuit with a MOSFET transistor, Q_1, which has a low drain-to-source resistance in the

THIS APPROACH REPLACES A POWER DIODE WITH A MOSFET TRANSISTOR OPERATING IN ON/OFF MODE.

on state. In the circuit, V_2 represents an ac power source of 36V. The load comprises 9Ω resistor R_L and 25-mH coil L_1. Comparator IC_1 generates the gate voltage for Q_1 when the voltage-

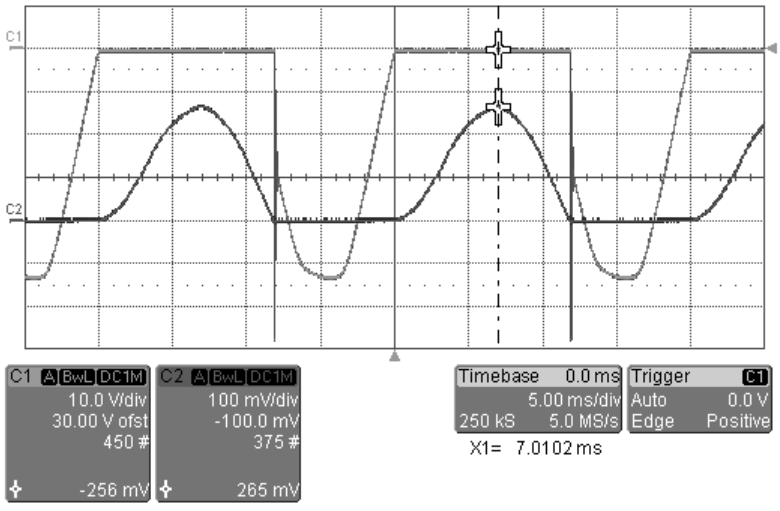

Figure 2 These traces show the rectifier's waveforms for an inductive load that comprises 9Ω resistor R_L and 25-mH coil L_1. Trace C2 shows a maximum load current of 2.65A. (The probe is 100 mV/A.) Trace C1 shows the anode-to-cathode voltage drop.

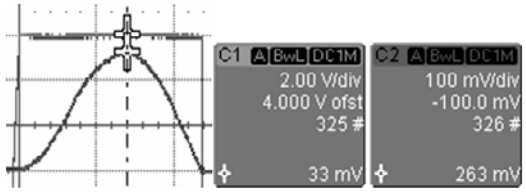

Figure 3 These traces show the condition of the rectifier with gate control. The MOSFET's parasitic diode is off, and the maximum voltage drop across the MOSFET is only 33 mV (Trace C1). Trace C2 shows the current through the rectifier.

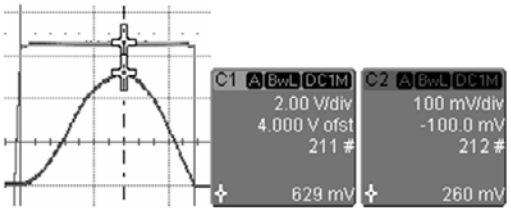

Figure 4 These traces show the condition of the rectifier without gate control. The MOSFET's parasitic diode is on, and the voltage drop across the MOSFET is 629 mV (Trace C1). Trace C2 shows the current through the rectifier.

supply anode is higher than the drain-voltage cathode. Thus, the source works as the anode of the rectifier, and the drain functions as a cathode. The circuit exploits the capability of the transistor in conducting currents in the source-to-drain direction. Turning on Q_1 effectively shorts its parasitic diode between the substrate and the drain, minimizing power loss. When the gate-to-source voltage is low, both Q_1 and its parasitic diode are off. Diode D_1 and resistor R_1 limit the voltage across the comparator inputs.

Figure 2 shows the load voltage and the voltage drop on rectifier Q_1. **Figure 3** shows the normal operation of the rectifier, in which, for a maximum load current of 2.65A, the voltage drop is 33 mV; Q_1 is working in the ohmic region. On the contrary, if you use the MOSFET, the voltage drop becomes 629 mV, yielding a maximum instantaneous power of 1.66W (**Figure 4**).

This approach is valid for any type of rectifier with any number of diodes. Moreover, you can use this circuit in dc/dc and dc/ac converters because, when you use power MOSFETs in bridge circuits, they can conduct both active and reactive currents. This approach avoids the need to use substrate-drain parasitic diodes in the MOSFET. EDN

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A LETTER FROM THE EDITOR

Coming out of **the recession**

By **Barbara Jorgensen**

A year ago, when *EDN* was compiling its list of the Top 25 distributors of 2010, the "revenue change" column was bleak. Since 2010's list was based on 2009 sales, 22 out of the Top 25 distributors registered negative growth for the calendar year.

This year, it's a different story. Not only did the Top 25 emerge from the recession—they bounded. Of the 23 distributors that grew in 2010, North American sales increased from a low of 7% to a high of 74%. Most, if not all, of the distributors on this year's list say they emerged stronger than ever from the recession.

There were drop-offs, however, due to the continuing consolidation of the distribution industry. The No. 4 distributor in 2010, Bell Microproducts, was acquired by Avnet Inc in July 2010. The No. 12 distributor on 2010's list, Converge, was acquired by Arrow Electronics Inc in June 2010. Still on the 2011 list, No. 9 Nu Horizons Electronics Corp and No. 22 Richardson Electronics' RFPD business were acquired by Arrow Electronics during 2010, but the acquisitions were not completed until 2011. So look for a few new names coming in 2012.

Among the Top 10 on this year's list there was a little shuffling: Newark moved up the ranking from No. 8 in 2010 to No. 6 in 2011; Smith & Associates dropped from No. 7 in 2010 to No. 11 in 2011. Thanks to double-digit growth and new slots on the list, catalog distributors Allied Electronics (42% year-over-year growth) and Mouser Electronics (74% year-over-year growth) broke into the Top 10 in 2011.

Avnet remained North America's biggest distributor in 2011, topping $10 billion in domestic sales. Arrow Electronics remains a solid No. 2 with $8.2 billion in North American sales. The gap between the A-Team (Avnet and Arrow) and No. 3 distributor Future Electronics Inc remains pretty large: Future grew by 18% in 2010 to $3.5 billion in domestic sales. Globally, the rank remains the same: Avnet topped $22 billion in 2010; Arrow, $18.7 billion; and Future, $5.4 billion. There's also a completely new entrant on the Top 25 list: Flame Enterprises, a specialty distributor of components to the aerospace and defense industry, ranked No. 25 in 2011 with $78.3 million in sales.

As the electronics industry enters the second quarter of 2011, the global economic outlook remains uncertain. The supply chain is still reeling from the loss of life and the uncertainty of supply following the deadly earthquake and tsunami in Japan. Unrest in the Middle East and North Africa has cast a pall on oil and gas prices, making product movement around the globe increasingly expensive. The next few quarters will determine what 2012's top distributors list will look like; for now, *EDN* is happy to bring you the leaders of 2011.

Barbara Jorgensen has been covering the electronics distribution industry for 20 years.

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TOP 25 North American Electronic

		CALENDAR YEAR 2010						% OF REVENUE 2010				
Rank	Company name	North American revenue (millions of $)	Total revenue (millions of $)	Total revenue change 2009-2010	5-year compound annual growth	Public/ private	Independent/ franchised	North America	Europe	China	India	Japan
1	Avnet[7]	10,084.8	22,920.0	38%	12.69%	P	F	44.0%	31% (EMEA)	25% (Asia, including Japan)		
2	Arrow Electronics[8,9,10]	8,247.7	18,744.7	28%	11.0%	P	F	44.0%	30% (EMEA)	21% (Asia/Pacific)		
3	Future Electronics[1]	3,506.1	5,394.0	18%	N/A	PR	F	65.0%	N/A	N/A	N/A	N/A
4	Digi-Key Corp	1,026.3	1,518.0	64%	19.0%	PR	F	67.61%	14.87%	3.10%	0.07%	2.85%
5	TTI Inc	812.0	1,400.0	38%	10.9%	P	F	58.0%	33.0%	5.0%	0.50%	0.50%
6	Newark[4]	581.8	594.9	21%	N/A	P	F	97.8%	0.0%	0.0%	0.0%	0.0%
7	DAC	528.2	533.5	38%	N/A	PR	F	99.0%	0.0%	0.0%	0.0%	0.0%
8	Allied Electronics[2,6]	396.0	400.0	42%	11.0%	P	F	99.0%	0.0%	0.0%	0.0%	0.0%
9	Nu Horizons[9]	381.8	707.0	10%	N/A	P	F	54.0%	10.0%	17.0%	0.0%	0.0%
10	Mouser Electronics	338.6	498.0	74%	29.0%	P	F	68.0%	16.0%	7.0%	1.0%	1.0%
11	Smith & Associates[3]	323.0	380.0	-13%	N/A	PR	I	85.0%	N/A	N/A	N/A	N/A
12	Carlton-Bates[1,5]	321.7	338.6	22%	N/A	P	F	95.0%	N/A	N/A	N/A	N/A
13	America II Electronics[3]	231.0	300.0	18%	N/A	PR	I	77.0%	N/A	N/A	N/A	N/A
14	Fusion[3]	212.5	250.0	7%	7.25%	PR	I	85.0%	N/A	N/A	N/A	N/A
15	Sager Electronics	205.0	205.0	N/A	N/A	PR	F	100.0%	0.0%	0.0%	0.0%	0.0%
16	Dependable Component Supply[1]	197.0	303.0	28%	N/A	PR	I/F	65.0%	N/A	N/A	N/A	N/A
17	WPG Americas[1]	167.0	167.0	19%	N/A	P	F	100.0%	0.0%	0.0%	0.0%	0.0%
18	PEI-Genesis	151.3	194.0	22%	20.0%	PR	F	78.0%	19.0%	1.0%	0.5%	1.00%
19	Master Distributors	129.7	147.4	37%	N/A	PR	F	88.0%	4.0%	4.0%	1.0%	1.0%
20	Electro Sonic[1]	118.3	124.5	24%	N/A	PR	F	95.0%	N/A	N/A	N/A	N/A
21	Advanced MP Technology	114.6	382.0	32%	N/A	PR	I	30.0%	30.0%	35.0%	0.0%	0.0%
22	Richardson Electronics[1,10]	113.8	344.9	-31%	6.0%	P	F	33.0%	N/A	N/A	N/A	N/A
23	Bisco Industries	93.1	97.0	20%	8.0%	P	F	96.0%	1.0%	1.0%	1.0%	0.0%
24	Powell Electronics	80.0	100.0	N/A	10.0%	PR	F	80.0%	10.0%	5.0%	0.0%	5.0%
25	Flame Enterprises	78.3	91.0	12%	N/A	PR	F	86.0%	N/A	N/A	N/A	N/A

Distributors are ranked by calendar year 2010 North American revenue.

N/A = Not available

Revenue figures are gathered from financial filings, company-provided information, and *EDN* estimates.

Component Distributors

Rest of world	Total employees 2010	2010 revenue per employee ($ thousands)	% of revenue from VA services	% OF REVENUE 2010 Active components	Passive, electromechanical, interconnect	Computer products/ systems	Contract manufacturing	Services	Other	Web address
0.0%	17,300	1,324.9	N/A	36.0%	7.0%	57.0%	0.0%	0.0%	0.0%	www.avnet.com
5.0%	12,700	1,476.0	N/A	69.0%	20.0%	11.0%	0.0%	0.0%	0.0%	www.arrow.com
N/A	5,000	1,078.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	www.futureelectronics.com
11.50%	2,411	629.6	25.0%	45.28%	51.12%	0.0%	0.0%	0.0%	3.6%	www.digikey.com
3.0%	2,100	666.7	67.0%	0.0%	99.0%	0.0%	0.0%	0.0%	1.0%	www.ttiinc.com
2.2%	1,345	442.3	22.8%	15.8%	50.2%	0.3%	0.0%	0.0%	33.7%	www.newark.com
1.0%	660	808.3	N/A	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	www.heilind.com
1.0%	752	531.9	N/A	4.0%	61.0%	0.0%	0.0%	0.0%	35.0%	www.alliedelec.com
19.0%	653	1,082.7	N/A	85.0%	9.0%	6.0%	0.0%	0.0%	0.0%	www.nuhorizons.com
7.0%	795	626.4	8.0%	39.0%	53.0%	0.0%	0.0%	0.0%	8.0%	www.mouser.com
N/A	307	1,237.8	N/A	74.0%	22.0%	4.0%	0.0%	0.0%	0.0%	www.smithweb.com
N/A	N/A	N/A	N/A	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	www.carlton-bates.com
N/A	600	500.0	10.0%	75.0%	24.0%	1.0%	0.0%	0.0%	0.0%	www.americaii.com
N/A	100	2,500.0	16.0%	48.0%	32.0%	20.0%	0.0%	0.0%	0.0%	www.fusiontrade.com
0.0%	265	773.6	24.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	www.sager.com
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	www.dependonus.com
0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	www.wpgamericas.com
0.50%	601	322.8	70.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	www.peigenesis.com
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5.0%	272	1,404.4	23.0%	50.0%	27.0%	9.0%	0.0%	0.0%	14.0%	www.advancedmp.com
N/A	744	463.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	www.rell.com
1.0%	330	293.9	20.0%	1.0%	80.0%	1.0%	0.0%	0.0%	18.0%	www.biscoind.com
0.0%	210	476.2	40.0%	40.0%	60.0%	0.0%	0.0%	0.0%	0.0%	www.powell.com
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[1]Revenue figures and percentages are *EDN* estimates.

[2]Revenue figures are *EDN* estimates.

[3]North America revenue percentages are *EDN* estimates.

[4]Newark is parent company Premier Farnell's (West Yorkshire, England) main North American presence in electronic component distribution. Revenue represents FY end 01/31/10.

[5]Carlton-Bates is a subsidiary of WESCO Distribution.

[6]Allied is a subsidiary of Electrocomponents plc.

[7]Avnet completed the acquisition of Bell Microproducts in July 2010.

[8]Arrow completed the acquisition of Converge in June 2010.

[9]Arrow completed the acquisition of Nu Horizons in January 2011.

[10]Arrow completed the acquisition of Richardson Electronics' RFPD business in March 2011.

Design registration and compensation: **still a moving target**

Suppliers and distributors seek the right balance for design services.

By **Barbara Jorgensen**

In spite of all the technology available to the supply chain, a seemingly simple transaction still remains elusive: compensating distributors appropriately for a design win. Suppliers are more willing than ever to reward distributors for their engineering efforts, but commission practices, regional P&L (profit-and-loss) silos, and inconsistent pricing continue to thwart even the best intentions. Still, channel partners are working toward a common goal: making sure service and support efforts are adequately rewarded.

Suppliers and distributors agree they want the same thing: to assist customers with their design and win as many sockets as possible on a board. Suppliers and distributors ultimately benefit from the component sales associated with a design win, and customers—hopefully—will turn to these same partners for their next project. To that end, distributors register a design win with their supplier, which, in turn, will compensate the distributor for the effort.

The sticking point continues to be the way distributors are compensated for this effort. To aid in customer design, distributors have to hire engineers, who are considered a fixed cost in an organization that is largely sales-driven. To offset this expense, distributors look to suppliers to help defray some of the costs, such as training salespeople and engineers, paying a fixed commission on a design win, or providing a preferred margin on a production order. Ongoing problems exist with the latter two models: A fixed commission may not reflect the ultimate value of a production order. Even more challenging, a design win doesn't necessarily guarantee the winning distributor will fulfill a production order—OEMs or EMS providers may source from another distributor entirely.

"The model used to be, you would call on an engineer and the procurement group would reward you with a purchase order," says Chris Beeson, vice president of sales and production business at Digi-Key Corp. "Now with the evolution of OEMs and EMS—they require a lot of engineering work, but you may have no way of connecting that [work] to consumption."

Outsourcing was the first trend that distanced design work from manufacturing; offshoring has widened that gap. Suppliers recognize these problems and continue to work with their partners to tie effort to compensation. A fixed-commission model, for example, is structured to reward a distributor whether or not the distributor wins a production order. Suppliers increasingly have been awarding distributors global franchises to ensure an OEM or EMS has the option of placing a production order from a distributor that secures a design win. Still, the channel faces the problem of the disconnect between where the design and fulfillment take place and regional pricing structures that mean a design win in North America may not be worth as much when production takes place in China.

Ed Smith
President, Avnet Electronics Marketing Americas

Peter Kong
President, Arrow Global Components

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The stakes are high

The channel has always known that the stakes in demand-creation programs were high, but a recent report actually puts a price tag on a semiconductor design win.

"A design win in a high-value consumer electronics product could make $100 million or more during the life of the device," says Jordan Selburn, principal analyst for consumer platforms at market-research firm IHS iSuppli. This figure, of course, is for semiconductor sales over the product's lifetime, but still, that's a nice annuity.

Demand-creation programs that reward distributors for getting a supplier's chip designed into an end product are becoming more competitive. Distributors already compete against one another for design wins, often over the same product. The prize is a preferred price or a higher profit margin when the distributor finally ships a production order to a manufacturer. But here's the risk: Whether it's a supplier or distributor that assists them with a design, OEMs are going to place their fulfillment orders where it makes the most sense. This could be a distributor or it could be an EMS/ODM. OEMs will always try for the highest level of service at the lowest possible price.

The solutions sell

To deliver a high level of service, distributors have been moving toward providing solutions—entire designs—to customers, rather than individual products. This approach takes a combination of products, directs them toward an application, test drives these solutions, and offers them to the market. Instead of going to the customer with a single component, such as a chip, distributors will include that chip within a full solution—for example, a circuit board containing complementary capacitors, resistors, and connectors. Each of these components is equally important to the solution. Even longtime competitors appear side by side on the same board.

Distribution executives see an opportunity to embed themselves more deeply in their customers' design and supply chains. Customers can now choose from the best of the best in technology, but the selection process is more complex. By assisting customers in selecting semiconductor technology, distributors have the opportunity to sell compatible components on the rest of the board.

Suppliers haven't squawked about this situation as much as one would expect. Just getting on the board (as opposed to being the only supplier on the board) has become paramount. Part of the reason is suppliers have been segmenting themselves into increasingly focused entities. The former broadline semiconductor makers are leveraging their specialties. Customers can now cherry-pick among the best offerings in every technology. At the same time, culling through the nuances of every product has become more difficult. Distributors have stepped in to guide customers along.

The process works pretty well until it comes time to place a production order. Let's say Distributor A has been providing design assistance in Dallas for a product that will be manufactured in Beijing. Distributor A isn't franchised for one of the parts that's needed for manufacturing. Rather than split up the bill of material, the customer places the order with Distributor B. The disconnect between the design in Dallas and the production in Beijing takes Distributor A out of the picture.

While the Americas still account for most of the electronic industry's design work, Asia/Pacific was the second-largest center of design activity in 2010. IHS iSuppli notes that the design activity shows a significant amount of disconnect from where products are ultimately shipped. Nearly 60%—58.2%—of semiconductors shipped in 2010 went to the Asia/Pacific region. Only 15.5% of chips used in 2010 were shipped to the Americas; 13.8% went to EMEA, and 12.5% went to Japan.

Pricing adds to complications

Even if a distributor wins both a design and a production order, the value of the order could actually decline. Component prices in Asia are lower than those in the Americas and Europe. Electronics components flow freely around the world—that's the point of being global. However, this freedom is one of the very reasons achieving a global price is difficult. For the electronics supply chain, it's all about where an order is booked versus where an order is fulfilled and how channel salespeople are compensated. A distributor in the United States convinces a US-based designer to use Part A in an end product. For its effort, the distributor is compensated based on Part A's sales. The BOM on the product is quoted in the United States, and Part A is priced at $1. That $1 also builds in the supplier's profit margin.

The product's OEM uses a Singapore-based EMS to manufacture the product. The distributor, which has a sales office and warehouse near Singapore, can fulfill the EMS order. However, Part A sells for $0.75 in the Far East. Suddenly, the distributor's compensation goes down because the compensation was originally based on $1, not $0.75. The supplier's profit margin may erode to account for the difference between $1 and $0.75. And should the sale be recorded in Singapore or in the United States?

The solution—a single, global price—remains elusive. One of the reasons is the regional P&L silo. Even in the most global organizations, P&L is still measured on a regional basis. In the days when products were manufactured and sourced locally, this wasn't a problem. But the very nature of the global supply chain adds such complexities. There are costs associated with shipping products around the world, currency-exchange differentials, and various payment terms. On the surface, a global electronics industry should level the price playing field—the ability to manufacture anywhere and everywhere should even out the various costs of doing business. Dig a little deeper, though, and the realities of regional differences become apparent.

"We can't say 'one size fits all,'" says Gert Labuschagne, president of Newark. "We have to give the customer the choice: If they want to do business with us regionally we have regional inventory in position; but we are also global because we do business in all regions of the world. We have to give customers all the options."

Solving the problem

In the past, the actual process of registering a design was difficult for the channel—that aspect is improving. Distributors' and suppliers' systems are aligned, so the process has become pretty seamless.

"I think the systems are so well connected between us and the supplier that as we put registrations in they go to the supplier almost immediately," says Ed Smith, president of Avnet Electronics Marketing Americas. "That has come a long way—I don't think suppliers are as concerned with the [design-win] visibility. The way it used to be, we would have to do updates and reviews, and now you can pull a report and immediately see what's being worked on."

Some distributors don't participate in design-registration programs to make things easier for the customer. Most catalog distributors focus on making products easy to find, immediately available, and priced in small quantities. Engineers don't want to fill in forms or share a lot of design information, executives say.

"We play in the product concept phase all the way up to small and medium production, but volume is not the model we are set up to support," says Kevin Hess, vice president of technical marketing for catalog distributor Mouser Electronics. "Since we don't focus on the back end, we don't make a large effort to participate in design registration."

Distributors that do are trying to offset these obstacles by becoming more global—that is, ensuring their systems, franchises, and services are easily duplicated region to region. "Customers are more global, so we have multiple design centers from North America to Europe and Asia," says Avnet's Smith. "Design information has to be passed all around the world."

This globalization has required more cooperation between suppliers and distributors. "We have developed better, more sophisticated coordination with our suppliers to work together to provide solutions for our customers," says Peter Kong, president of Arrow Global Components. "We can assist our customers in every phase of their design, from new-product introduction through end-of-life. The best suppliers appreciate Arrow's capabilities and results, and have developed programs that recognize that in many ways."

One strategy Future Electronics Inc focuses on is having inventory available when and where it is needed. "I think first of all, we as a privately held company have a huge advantage," says Lindsley Ruth, corporate vice president for Future Electronics. "We can invest in assisting in design and for the long run."

Buying and holding inventory ties up a lot of distributors' cash—a strategy that often isn't rewarded by investors. "The timing from an OEM's concept to production could be 12 to 18 months," says Ruth. "We hold the inventory up front, and we can wait for the long-term return."

Additionally, Future has invested in IT systems that transfer information seamlessly. "Our ability to track [design wins] is best in class; we have procedures for business transfer, and we work with our suppliers so our processes are aligned," Ruth adds. "It also gets down to basic communication—we let our people know when something moves from one place to another—and we make sure everyone is on the same page in terms of communication."

In spite of communication, IT investment, and best efforts of suppliers, distributors still may not end up in the black on a design win. It's a dilemma that Digi-Key—classically a catalog distributor—is struggling with. Digi-Key offers both catalog and production volumes but admits balancing both can be tough. "We've had customers say, 'Why are you doing this to us?'" explains Beeson. "We've worked with them on design, and then all of a sudden we pass them off to a volume distributor." At the same time, he says, suppliers want to see things through to the end. "We've won a print position for a supplier and then we pass the baton from engineering to procurement," Beeson adds. Digi-Key is in an ongoing dialog with both suppliers and customers. "Our greatest challenge is positioning our suppliers' products and services to be in line with customer desires," he concludes. ●

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The realities of **global pricing**

Structural and perceptual challenges continue.

By **Barbara Jorgensen**

Supply-chain partners agree that a single, global price for a component no matter where in the world it's sold would eliminate a lot of red tape in the channel. The absence of a global price is one reason why compensating distributors for demand-creation efforts is so difficult. But the realities of doing business in a global market add even more complexities to an already challenging situation.

Demand-creation programs usually reward distributors based on the value of a production order. The problem is component prices differ from region to region, so the value of that production order also differs region to region. A single global price would eliminate the guesswork around how much effort a distributor should expend pursuing a design win versus how much reward there will be for the effort.

"Suppliers do have a clear picture about effort versus payment," says Ed Smith, president, Avnet Electronics Marketing Americas. "The work we do in support of the design is realized in the capture of the [order fulfillment]."

Expectations and perception

Global pricing remains elusive for both structural reasons—the way business is conducted—and perceptual reasons. Prices for raw materials, equipment, and labor do differ from region to region, and customers expect to pay lower prices in Asia.

More than a decade ago, the electronics industry determined that manufacturing in China would make products less expensive because wages in China are lower. While it is true that wages in China are lower, it's not true that everything made in China is automatically cheaper. Moving components into, out of, or around China carries a cost. But customers expect prices to be lower in the Far East; therefore, they are loath to pay US- or EU-level prices. So to remain competitive, component makers lower their prices—in the Far East.

For the distribution channel, this means that compensation for demand-creation efforts loses some of its value when they move offshore. For the electronics supply chain, a design win is about where an order is booked versus where an order is fulfilled. For example, a distributor in the United States convinces a US-based designer to use Part A in an end product. For its effort, the distributor is compensated based on Part A's sales. The BOM on the product is quoted in the United States, and Part A is priced at $1. That $1 also builds in the supplier's profit margin.

The product's OEM uses a Singapore-based EMS to manufacture the product. The distributor, which has a sales office and warehouse near Singapore, can fulfill the EMS order. However, Part A sells for $0.75 in the Far East. Suddenly, the distributor's compensation goes down because the compensation was originally based on $1, not $0.75. The supplier's profit margin may erode to account for the difference between $1 and $0.75.

There's also the question of whether the sale should be recorded in the United States or Singapore. This is one of the structural reasons why global pricing remains elusive. Even in the most global organizations, profit and loss are still measured on a regional basis. Currency conversion also has an impact on pricing.

Global price versus lowest price

A second reason global pricing is difficult is fear.

Gert Labuschagne
President, Newark

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Component makers and their resellers fear that "global price" will become the equivalent of "lowest price." The lower the price, the lower the profit margin. The lower the profit margin, the harder it is to make a buck or a euro or a yen on a component sale.

This is a valid fear. What buyer wouldn't source components from a low-price region if he or she could? The problem is price and cost don't mean the same thing. The cost of sourcing a part from Asia could ultimately be higher than the component's listed price. Until the supply chain can negotiate terms on the basis of cost and not price, global pricing remains elusive.

In the days when products were manufactured and sourced locally, this wasn't a problem. But the very nature of the global supply chain adds such complexities. There are costs associated with shipping products around the world, currency-exchange differentials, and various payment terms. On the surface, a global electronics industry should level the price playing field—the ability to manufacture anywhere and everywhere should even out the various costs of doing business.

Consistency does exist

There is one distribution segment that is relatively impervious to the problems of global pricing: catalogs. Catalog distributors specialize in small-volume orders and provide a high level of service: ease of use, overnight delivery, and a variety of other engineer-friendly services. Engineers are primarily concerned with component costs—purchasing is—and negotiating pricing over a half-dozen parts is not an effective use of time.

High-volume purchases worth millions of dollars are negotiated all the time. "Our focus is to have the product in stock and turn the order around in a day," says Gert Labuschagne, president of catalog distributor Newark. "Our list prices are not based on going back and forth to the supplier."

Some catalogs purchase and distribute from a single location, which enables them to charge a single or list price. Others conduct business in local currencies and languages. Catalog distributor Mouser Electronics, for example, prices its components regionally and transacts in local currency. "We have 14 different locations and we try to deal in the regional language and currency," says Kevin Hess, vice president of technical marketing for the company. "All the pricing is specific to that country. The reality of global pricing is that [prices are not just based on] US dollars; it can be in euros, and people buy in euros. So our strategy is to be price competitive within that region."

Outside of the catalog industry, though, deterring a fair price is still a challenge. Open-market distributors frequently list market prices, and other pricing tools are available. FreeBenchmarking.com was developed to assess pricing competitiveness, highlight areas for savings, and even measure price trends over time.

"Using the clients' annual volumes, we determine the spending on components at 'best-in-class' and 'average' reference prices and compare that to actual client spending where we have component matches," says Ken Bradley, president of Lytica Inc, which developed the tool. "This allows us to measure, based on total and commodity spending, how competitive a client's pricing is."

"Our desire," he adds, "is to make FreeBenchmarking.com the go-to reference for electronic components price benchmarking. We have one goal: to help our clients achieve competitive advantage, and the feedback we continue to receive from the industry has been phenomenal. Our aim is to ensure our clients have access to the most current and valuable information possible."

Bradley emphasizes price and cost remain two separate issues. Distributors also make that distinction. "Our 'price' is based on the value of the service delivered," says Peter Kong, president of Arrow Global Components. "Most of our customers are local, and, very often, there are distinct value propositions for products and services delivered among regions. At Arrow, we believe local service and support provide higher value for a good portion of our customer base. The price is also affected by local costs and alternatives."

Distributors will continue to scale their service offerings based on demand rather than price. "We have customers in North America that expect to receive a high level of engineering support; there are those that outsource those design efforts and there are customers that don't want a lot of contact with [a distributor or a supplier]," says Lindsley Ruth, corporate vice president for Future Electronics. "All of our offerings depend on the level of service and the quality of support our customer requires."

Lindsley Ruth
Corporate Vice President, Future Electronics

Global gurus **speak out**

Executives discuss managing hundreds of suppliers, thousands of customers.

Executives from the top 3 global distributors—Avnet Inc, Arrow Electronics Inc, and Future Electronics Inc—discuss how they manage some of the complexities of risk management, compensation, and pricing without losing focus on the all-important end customer.

Gerry Fay, senior vice president, Supply Chain Solutions, Avnet Electronics Marketing

The following is an excerpt from an article Fay authored on risk management in the supply chain.

Today, the stakes are too high and the risks are too prevalent to leave anything to chance. To meaningfully mitigate supply chain risks, each and every player—from raw materials supplier through end product manufacturing—must actively manage the vulnerabilities that are inherent in their particular portion of the ecosystem. A failure to do so could turn a relatively minor disruption into a major crisis.

This is an aspect of risk management that I believe many players within the supply chain do not fully grasp. The potential damage a supply chain disruption can cause is not always repaired by simply smoothing over some customer service complaints. There can be a tangible—and very costly—impact on a company's overall valuation, including lower revenue, higher costs, and shareholder value loss.

Research from the DuPree College of Management at the Georgia Institute of Technology shows that the total shareholder value loss associated with a supply chain disruption can be as high as 25%, regardless of who or what has caused the glitch.

Yet, according to a Supply Chain Council member survey, less than half of enterprises have established metrics and procedures for assessing and managing supply risks. Furthermore, these organizations lack sufficient market intelligence, processes, and information systems to effectively predict and mitigate these risks. Without this data, these companies are putting their supply chains at risk without even realizing it.

While there is no one-size-fits-all supply chain risk management strategy, one element that I believe every risk management plan should include is assessment. An assessment tool such as the Supply Chain Operations Reference (SCOR) model provides a comprehensive set of metrics covering all levels of the supply chain.

Using this information, users can determine where to focus their risk management emphasis based on their relative performance versus their peer set and whether they are managing their supply chain based on cost versus reliability, responsiveness, or agility. They can then determine whether it is more important to be superior, have an advantage, or be at parity, and then reprioritize their investments to achieve the status they desire.

Managing supply chain risk proactively is rapidly becoming a competitive differentiator in our industry. Using the SCOR model as a foundation for your risk management program will help ensure that you will be ready to catch whatever life throws at you.

Gerry Fay
Senior Vice President, Supply Chain Solutions, Avnet Electronics Marketing

Peter Kong, president, Arrow Global Components

Kong answered questions posed by **EDN*:***

How do you weigh the "reward" you can expect from a customer versus the resources you devote to assisting that customer? Do you treat them the same, or do you have to make decisions regarding your own resources?

A Today Arrow has complete product-life-cycle service capabilities, and we tailor our value proposition to our customers. Arrow's goal is to provide services that will satisfy their needs, and

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we invest accordingly to deliver our value proposition. Our large customers typically do not require design support but need a complex supply-chain solution, which could also include services like programming, end-of-life services, and reverse logistics. Our Arrow Alliance model fits this [situation] well. The middle 30,000 customers require full service and local support. These customers are supported by our field engineers and an extensive global network. Arrow has a terrific offering for our small and midsize customers that includes a host of Internet capability, access to a large pool of inventory, and tailored support. Our suppliers appreciate this approach, as it allows us to present their technology to market at all customer levels and help them identify the best prospects for their latest offerings.

Is the onus on the distributor or the supplier to resolve issues when the US price (quoted based on design) differs from the Asia/Pacific price (based on fulfillment)?

A Our "price" is based on the value of the service delivered. Most of our customers are local, and, very often, there are distinct value propositions for products and services delivered among regions. At Arrow, we believe local service and support provide higher value for a good portion of our customer base. The price is also affected by local costs and alternatives. We are also seeing more design opportunities and activities in Asia.

How proactive have suppliers been in helping distributors manage their resources in terms of design assistance? Are they better in terms of awarding design-wins, or is that help coming in the form of training and other?

A We have developed better, more sophisticated coordination with our suppliers to work together to provide solutions for our customers. We can assist our customers in every phase of their design, from new-product introduction through end of life. The best suppliers appreciate Arrow's capabilities and results, and have developed programs that recognize that in many ways. Many do not have the resources to support the broad and growing customer base and rely on us to do that for them. In turn, they provide us with product information, application knowledge, and training. Again, the best suppliers with the best distribution programs recognize and leverage our capabilities.

Lindsley Ruth, corporate vice president, Future Electronics

Ruth answered questions posed by EDN*:*

How has your approach to design services changed over the past few years?

A I think it depends on the geography we are talking about. In North America, we have customers who receive a certain level of engineering support because they are trying to outsource more of their design efforts. They are looking for a partner that can design a solution—someone that can go beyond the component-level design. Suppliers, distributors, and design houses all play a role in assisting customers—it depends on the service and the quality the customer is looking for in terms of the level of support.

How we deploy our design engineers depends on the type of design the customer is looking for. Today, the challenges are, more than anything, designers are being asked to do a lot more. Information exists on the Web, but someone has to come in who is nonbiased, can cull through that information, and can provide the best solution in a cost-effective way. There is so much information available it can get overwhelming.

What specifics are your customers asking for, in terms of either product knowledge or verticals?

A I think first and foremost it is a total design solution they are looking for—from design to replenishment if need be. We don't just want to be a design or fulfillment operation, we want to offer complete solutions—the kind of resource sharing and integrated type of partnership customers are looking for. We can help customers in a number of ways, from design and procurement solutions to business intelligence, and ultimately become experts in our customer's application. We have added a lot of salespeople with an engineering background who may not be able to answer a specific question, but they can facilitate a solution by going to our experts and getting back to the engineer.

As more distributors offer design help, how do you continue to differentiate yourself?

A I think first of all we have a privately held company and we have a huge advantage. We can invest in the design for the long run, from concept to production. We buy inventory up front, and we have a global IT suite with ability to track [a design] that is best in class. We have procedures for business transfer and visibility of the designs, and we capture as much of that work as possible. Our supplier processes are also aligned, and the rest gets down to basic communication. We let our people know when a project transfers from one place to another, we have the inventory in place to support the job in the region, and we replenish it when necessary. Everyone is on the same page.

EDS' design side

With the electronics-components industry riding strong growth, one of its premier trade shows, EDS (formerly, Electronics Distribution Show, www.edsconnects.com), is also expecting to see a larger number of attendees this year. Component suppliers, distributors, and independent sales representatives will meet for three days of meetings, planning, and shopping for new partners May 24 through 26 at the Paris/Bally's hotel complex in Las Vegas. Although many view EDS as a sales-focused event, it offers a chance for component suppliers to show off their new technology and designs.

> Japan's difficulties affect the electronics supply chain, so EDS will be an opportunity for partners to work on approaches to problems.

"There is a design component to EDS, primarily on the show floor, where component suppliers introduce emerging technology," says Lew LaFornara (**photo**, left), vice president of product management and supplier marketing for distributor TTI Inc (www.ttiinc.com). Typically, the distributor or manufacturing rep, rather than the engineer, does the shopping for new products, he adds. Nevertheless, some of the seminars target emerging technologies. Component manufacturers use the show to introduce products that they will ultimately roll out to the design community.

With the components industry well into a second year of strong growth, EDS should also swell. "I expect the show to be bigger and more important," says Mark Larson, president and chief executive officer of distributor Digi-Key (www.digikey.com). "2010 was an incredible year for our industry, and 2011 is off to a great start. Suppliers and distributors are armed with enthusiasm and have the resources to implement."

Managing growth will likely be a major focus of the show. "Currently, electronic-component growth is in the double digits," says Robert Willis, president of the ECA (Electronic Components Association, www.ec-central.org). "Part of the buzz of the show will be discussions about whether the industry will continue at this pace and the prospects for increased hiring during the second half of this year."

EDS gives companies throughout the electronics supply chain an opportunity to meet with dozens of partners during one trip. "For us, EDS is a wonderful show," says Alex Iuorio (**photo**, right), senior vice president of supplier marketing at Avnet Inc (www.avnet.com). "Historically, this is a purview of our [IP&E] interconnect, passive, and electromechanical suppliers. This [show] is a great and efficient way to get together with suppliers in a rapid-fire way to go over our mutual growth objectives."

Avnet expects to divide its EDS goals into four areas, according to Iuorio. Those areas include e-commerce, in which the company is moving up the sale and number of parts. "We have our IP&E business," he explains. "We have our mass market of 100,000 customers in the American field. And we have our embedded business."

Iuorio also notes that EDS now goes beyond the traditional IP&E suppliers. "We're seeing more semiconductor suppliers joining the EDS fray. About 20 to 30% of our suppliers at EDS will be semiconductor suppliers."

As well as meeting with partners, Avnet also plans to attempt to lure new suppliers. "Our strategy is to set up meetings with individual suppliers," says Iuorio. "We'll also spend time on the floor."

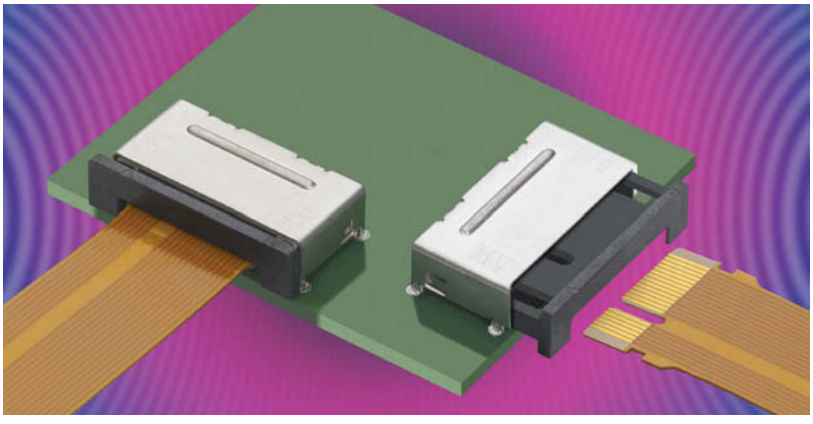
Events in Japan will also be major discussion points at EDS. "I would expect that the tragic earthquake, the resulting tsunami, and their impact on the manufacturing infrastructure of Japan will be points of relevant discussion," says Digi-Key's Larson. "Other issues I anticipate during the show will include shortages resulting from raw materials such as tantalum powder."

Japan's difficulties affect the electronics supply chain, so EDS will also be an opportunity for partners to work on approaches to problems. "Japan will affect the otherwise-positive mood of EDS. Japan's major event creates one more factor in the supply-chain management and demand fluctuation," says Avnet's Iuorio. "Many of our suppliers have a presence in Japan. The components necessary to build certain products come from Japan. A lot of the commodities come from Japan."

Conference producers are already planning for EDS 2012, when the show will move to a new hotel. "There should be excitement this year about taking the EDS energy to a new venue at the Cosmopolitan in 2012," says Willis from the ECA. "That move will continue to build EDS as a critical piece of any company's marketing strategy."**—by Rob Spiegel**

productroundup

CONNECTORS



ZIF flex data link and socket are high-speed and rugged

The ZHDL2 ZIF (zero-insertion-force) flex data link and ZHR5 series sockets target use in high-speed, rugged cable-to-board applications in which signal integrity is important. The 0.5-mm-pitch system features a rugged latching system with a notch on the flex data link for positive retention and ZIF on the pads. Standard weld tabs on the socket provide stable connection to the board. The typical speed for the differential-pair flex data link is as great as 9 GHz at 7-dB insertion loss for a 5-in. length and 4.14 GHz at 7-dB insertion loss for a 10-in. length. The devices support SAS, SATA, Fibre Channel, PCIe, Ethernet, and InfiniBand high-speed-I/O-protocol standards. The socket sells for approximately 5 cents, depending on quantity and connector configuration.
Samtec, www.samtec.com

IP67-rated series adds RJ-45 Ethernet connectors

This IP67-rated series of water-resistant connectors now includes RJ-45 Ethernet I/O ports, allowing designers to incorporate these ports in harsh environments. The connectors provide protection from contamination and moisture and feature mechanical stability, temperature resistance, vibration immunity, and EMI/RFI shielding. The family features a one-sixth-turn bayonet coupling for fast and secure mating and unmating. To optimize chemical resistance, ultraviolet resistance, EMI shielding, and tolerance of physical abuse, the connectors come in

black, blue, green, yellow, red, and white plastic; metalized plastic; and nickel-plated zinc die cast. The connectors also have gold-plated contacts. Prices for the connectors start at $8 (OEM quantities).
Conec, www.conec.com

RF coaxial-cable assembly features low loss

The CCSMA-MM-LL335 series of cable assemblies and low-loss RF coaxial cables operate as fast as 18 MHz and feature attenuation ratings of 0.03 dB/foot at 500 MHz and 0.2 dB/foot at 18 GHz. The cables have a minimum bend radius of 1.5 in. and are available in 36-, 48-, and 60-in. versions. They come with high-frequency SMA or N-type connectors featuring rugged stainless-steel solder-clamp construction

and heavy-duty strain relief with a neoprene jacket. These low-loss cables offer shielding effectiveness of greater than –100 dB with an operating-temperature range of –45 to +125°C. Prices range from $210 to $335 per cable, depending on length and connector.
Crystek, www.crystek.com

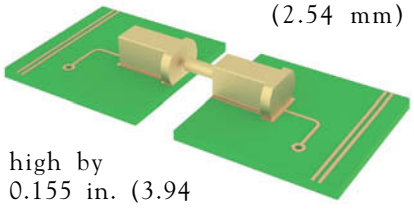
Use elastomer socket in Infineon BGA221

The SG-BGA7162 socket for 0.4-mm-pitch, 221-ball BGAs operates at bandwidths as high as 10 GHz with less than 1 dB of insertion loss. Contact resistance is typically 20 mΩ per I/O. The socket connects all pins with 10-GHz bandwidth on all connections. You can mount the socket using supplied hardware on the target PCB without soldering. The socket also

incorporates a quick-insertion method using shoulder screws and a swiveling socket lid, allowing you to quickly change out ICs. The socket verifies the function of ICs in a development system with superior electrical performance. The pin's self-inductance is 0.15 nH, and mutual inductance is 0.025 nH. Capacitance to ground is 0.01 pF, and current capacity is 2A per pin. The SG-BGA-7162 sells for $352 (one).
Ironwood Electronics, www.ironwoodelectronics.com

Horizontal spring pin targets board-interface applications

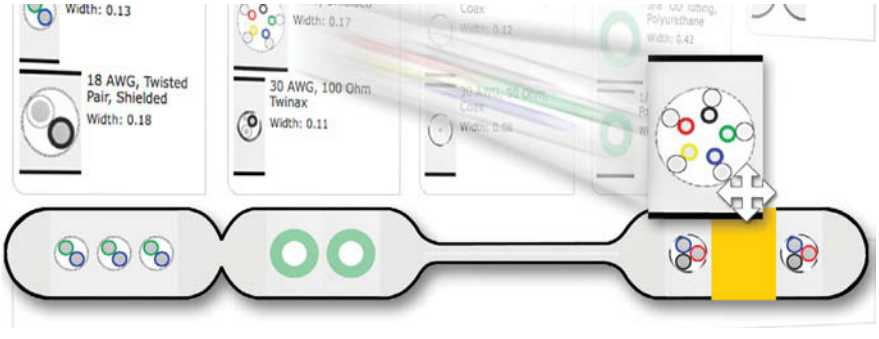
The low-profile, horizontal, surface-mount 0967 spring pin targets use in board-to-board or device-to-board in edge-board-interface applications. Whereas most spring pins mount vertically on a PCB, the 0967 mounts parallel to the PCB so that plunger travel is horizontal to the board's surface. You can daisy-chain parallel PCBs using the 7937 horizontal SMT target pin and the 0967 spring pin on opposing boards. The 7937 provides an area of approximately 0.1 in. (2.54 mm)



high by 0.155 in. (3.94 mm) long for the plunger of the 0967 to mate with. The 0967-0-15-20-75-14-11-0 sells for $491.40 (5000) for 1000 pieces, and the 7937-0-00-15-00-00-03-0 sells for $146.10 (5000) for 1000 pieces.
Mill-Max Manufacturing Corp, www.mill-max.com

Application lets users design cables online

The Cable Configurator Web application features a drag-and-drop option that allows users to design any flat cable and immediately get a drawing and a quote. Users can construct cables of many elements, including shielded power conductors, shielded signal conductors, video and coaxial wires, tubing for fluids or gases, and other design elements. Users can combine any of these elements in a flat cable as wide as 3.75 in. Users can also delete and move elements and add dividers and other optional elements.
Cicoil, www.cicoil.com/cables/configurator.asp



Silo slip-up

Wikipedia describes a "functional silo" as a situation that exists when the business processes of a functional unit within an organization focus inwardly on its functional objectives. This situation becomes problematic when the direction of focus creates barriers that serve no reasonable business purpose and negatively affects the unit's ability to serve its role in the broader mission of the organization. Although many companies endure poor cooperation between departments, a company I used to work for carried the functional-silo scenario to extremes.

It is reasonable to group production and engineering into separate organizational departments and reasonable to individually rate and reward each division. The risk of such motivation, however, is that a department may focus on itself, develop thick walls, look only up and not sideways, and avoid cooperation or even communication with other departments.

Business-school remedies for this behavior include cross-training employees, holding "big-picture" cross-functional meetings, and implementing rating and reward systems that look at total business efficiency and departmental efficiency. At this company, the production and engineering departments had the same cooperative relationship as the Hatfields and the McCoys.

I had designed a remote wired terminal with a 50-key keypad and a digital data link using binary PAM (pulse-amplitude modulation). It seemed to work well, and the company shipped thousands of the product. After a year or so, however, I began hearing rumors that the product was no longer tripping happily off the production line. Sure enough, I got a call from the production department. They required my presence at a meeting to discuss the terminal.

At the meeting, the production team surrounded me and informed me that the rejection rate on the product was unacceptably high.

"What's the rejection rate, exactly, in percentage points?" I asked.

"About 60%," they responded.

I then zipped up my flak jacket and peppered them with questions. "Gosh—60%? How long has this situation been going on?"

"More than three months," they replied. "We have 2000 units in the 'dead' pile. We're running out of places to store them. There's something wrong with the design."

"Why exactly didn't you talk to me sooner?" I asked.

"Some of them work," they replied, cleverly avoiding my question.

"Could I, perhaps, borrow a bad one?" I asked, hands clasped in supplication, head properly bowed.

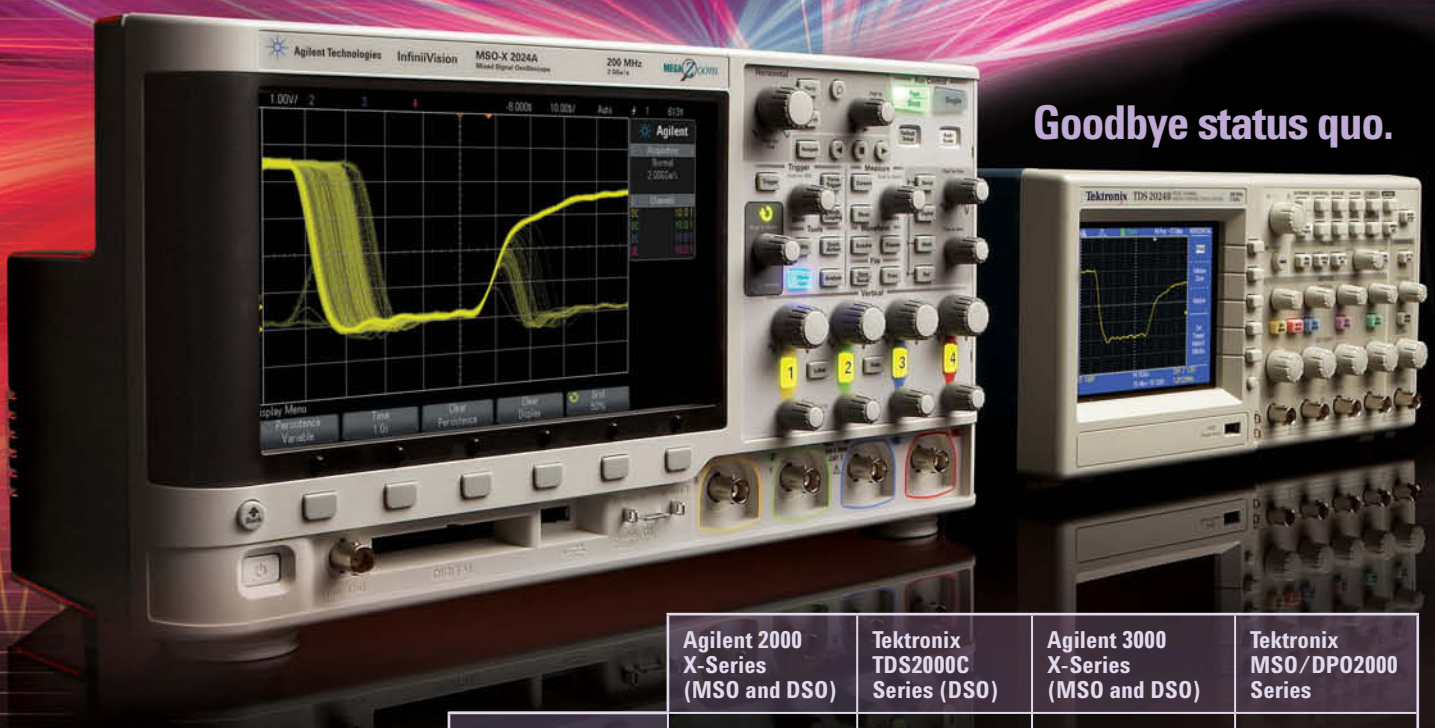
In days, they located a bad one, and I took possession. Back at the lab, I quickly diagnosed a bad demodulator. An LC bandpass filter's response was marginal. Comparing the inductor to the one in my original design, I found that someone had replaced the 470-µH cordwood part I had specified with a smaller 470-µH part. As a result, dc current was saturating the core, ruining the quality factor and turning the 470-µH part into a 200-µH part. I assumed that the purchasing department was trying to cut costs.

Notice the destructive effects of functional silos: Purchasing received a reward for saving a few cents by using a new inductor, but every failed terminal cost many dollars in stagnant inventory, test-technician time, and the movement of processing units into and from storage. Production's tardy reporting of the problem allowed terminals with the new inductor into customers' hands, resulting in field failures, shipping and travel expenses, and unhappy customers. Restoring the original inductor fixed the problem. EDN

Larry K Baxter is founder of the Web site CapSense.com and author of* Capacitive Sensors *(IEEE Press, 1997).

DANIEL VASCONCELLOS

Hello future.



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Max update rate (waveforms/sec)	50,000	200**	1,000,000	5,000
Fully upgradable	Yes	No	Yes	No
Function Generator	Yes	No	Yes	No
Notes:	**Refer to Agilent Pub 5989-7885EN for update rate measurements Data for competitive oscilloscopes from Tektronix publications 3GW-25645-0 and 3GW-22048-1 Measurements taken on same signal using Agilent MSOX2024A and Tektronix TDS2024B Screen images are actual screen captures and scopes are shown to scale			

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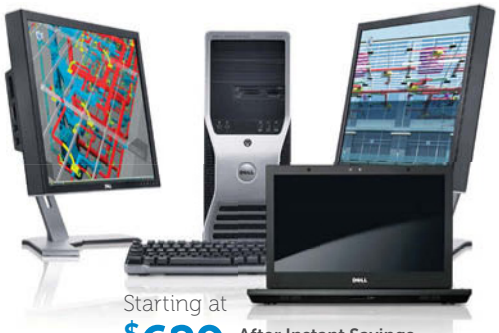

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